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PUBLIC ADDRESS SET

AN/UIQ-10

by

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Communications & Electronics Branch

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Final Report

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Public Address Set AN/UIQ-10 was developed to meet the requirements of the Marine Corps for a family of tactical ground and airborne public address systems to replace existing systems. All development objectives were met. Tests by the Marine Corps and the Army showed that the AN/UIQ-10 was superior to existing systems in performance, portability, flexibility and efficiency.

Airborne versions provided superior range performance to existing systems.

The Marine Corps is standardizing the AN/UIQ-10.

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BLOCK 20. ABSTRACT CON'T

It is recommended that the US Army adopt the ground and airborne versions of this system.

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INTRODUCTION

During 1969, the US Army Land Warfare Laboratory initiated development of a public address system in response to a CDOG requirement (Para. 1312 (A)b(2)) for "Improved Audio Dissemination Systems" which stated that there were no satisfactory or sufficiently versatile PA systems available. The objective was to develop a one-man system which provided maximum capability within reasonable size and weight restrictions. The prototype resulting from this effort, designated AN/UIH-7, employed highly efficient, pulse-modulation amplifiers. The basic system was mounted on a rucksack frame, weighed 35 pounds (with battery) and provided approximately 60 watts of output power.

About the same time, the Marine Corps was completing development of a prototype public address set, AN/UIQ-8. It also employed pulse-modulation circuitry; however, it was a 250 watt system requiring two men to carry it.

While these developments were progressing, a requirement from the field came into Marine Corps Headquarters for a lightweight, one-man PA system. USALWL was approached by the Marine Corps for assistance in satisfying the requirement. Using components of the UIQ-8 prototype and many of the concepts of the UIH-7, a "mock-up" of a two manpack system was configured at USALWL. All of the electronics and a single speaker horn were mounted on one rucksack (thereby providing a basic one-man unit). Three additional speakers were mounted on a second rucksack to provide a high-power (250-300 watt) capability. This configuration was operationally tested at the Marine Corps Development Center and then served as a model for development of the AN/UIQ-10 (Figure 1).

Development of the PA system, AN/UIQ-10, commenced in January 1971. An XLW-1 prototype was completed by mid 1971. Consideration of this prototype showed the need for numerous minor changes which were subsequently incorporated into the units that were fabricated for field tests. The final unit to be fabricated was termed the XLW-2 model and was retained by LWL for application of all future changes. It is this model that is the prototype for MIL SPEC MIL-P-2899 (MC) which is currently being used for a production contract by the Marine Corps.

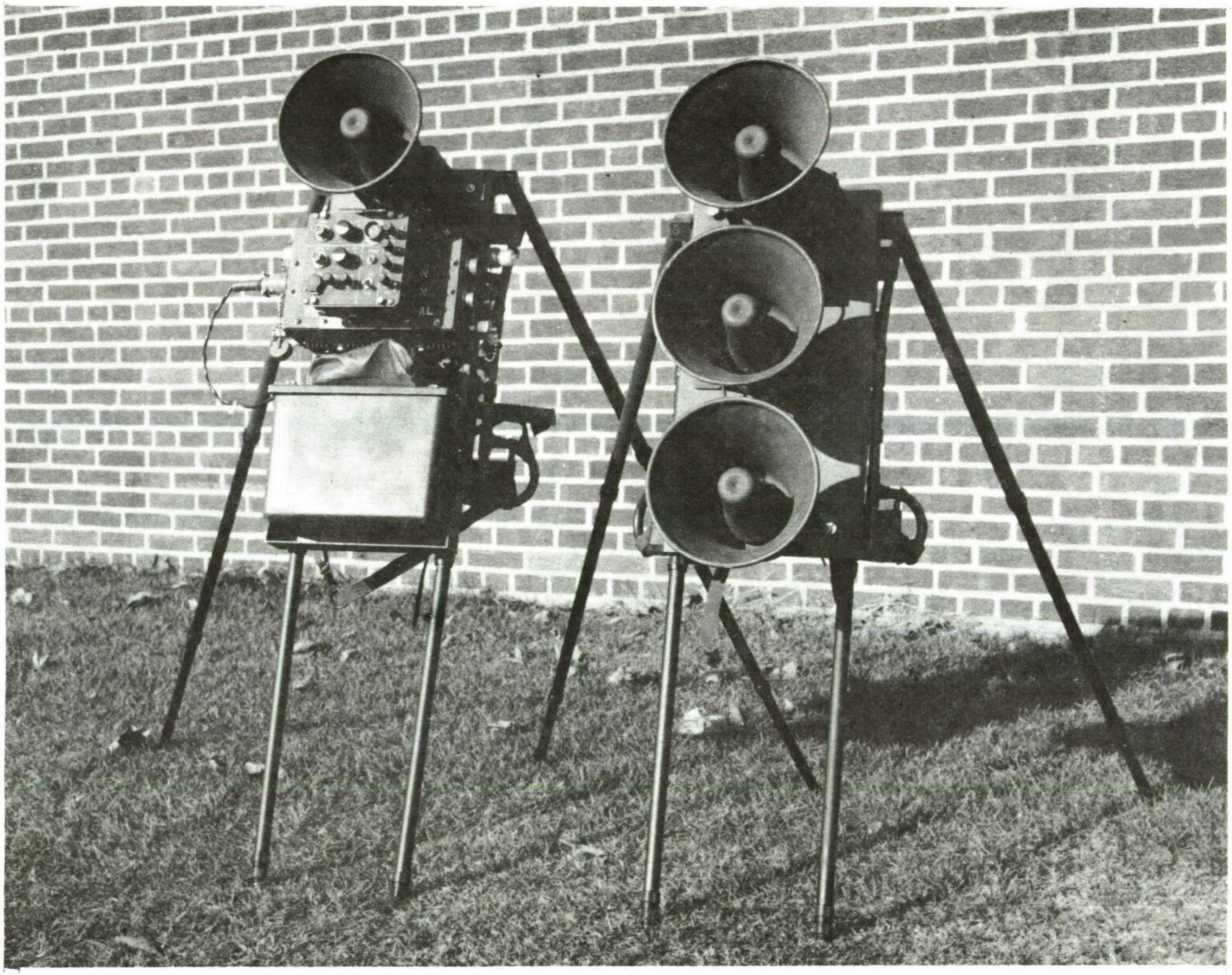

Figure 1. Modified PA Set AN/UIQ-8

DESCRIPTION

Public Address Set, AN/UIQ-10 is a lightweight, high-efficiency voice amplification system, primarily intended to provide the military services with a practical man-pack public address capability in the tactical environment. The complete set is carried by two men, and provides up to 250 watts output to four horn-type speakers. One man can pack a completely functional subsystem which produces up to 65 watts output to one speaker.

The major components of the AN/UIQ-10 are also capable of applications other than the man-pack role. With different installation hardware they can be used in ground vehicular, aircraft, helicopter, and fixed-plant applications.

Prototypes of airborne systems, PA Set AN/AIQ-2 and a smaller system were designed, fabricated and tested. These will be covered later in this report.

Public Address Set AN/UIQ-10 consists of the following items.

Quantity	Description
1	Amplifier, Audio Frequency, AM-6482/UIQ-10
1	Control, Amplifier, C-8967/UIQ-10
1	Loudspeaker, LS-608/UIQ-10
1	Accessory Kit (microphone, control cable, radio cable, power connector; in carrying pouch)

All on Mounting Plate Assembly MT-4455/UIQ-10

1	Loudspeaker Assembly, LS-611/UIQ-10, Three Speakers

On Mounting Plate Assembly MT-4456/UIQ-10

Physical Description

The AN/UIQ-10 Public Address Set (Figure 2) consists of two distinct man-pack units. The basic unit is a complete public address system in its own right, including a battery, with output limited only by the single loudspeaker with which it is equipped. The second man-pack, designated Loudspeaker Assembly LS-611/UIQ-10, adds three additional speakers to permit exploitation of the full power capability of the amplifier.

Each man-pack is based on a mounting plate to which the other components are attached. Both units include the standard lightweight Army packframe, secured to the mounting plate, as the interface between the equipment and the man carrying it. These packframes permit a man to carry a heavy load in relative comfort. Both units also include a set of four telescoping legs which extend and spread to support the equipment in the operating position. The set will accept 28V external DC power from aircraft and vehicles.

The basic system (Figure 3) consists of the Amplifier Unit, Control Unit, one Loudspeaker LS-608/UIQ-10, and an Accessory Kit. With batteries attached, this unit weighs 35 pounds. This system is nomenclatured Public Address

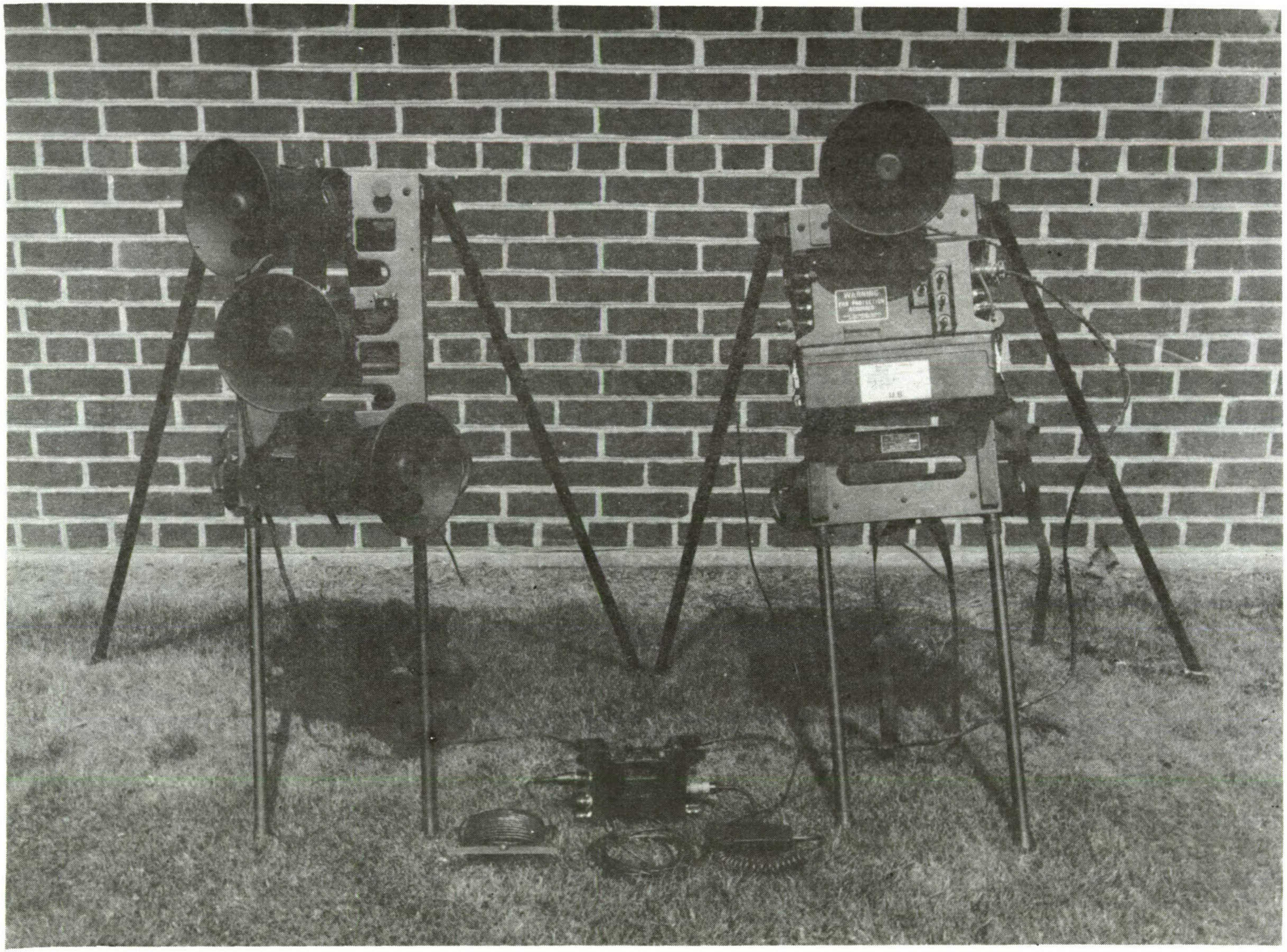

Figure 2. Public Address AN/UIQ-10 Shown in Operating Position with Telescopic Legs Extended

Figure 3. Public Address Set AN/UIQ-11 Shown Backpacked

Set AN/UIQ-11.

Loudspeaker Assembly, LS-611/UIQ-10 consists of three Loudspeakers LS-608/UIQ-10 in pivoted mountings on a back-plate, with an integral cable to connect to the amplifier unit during operation. This unit weights 31 pounds. With this Assembly added to the AN/UIQ-11, it becomes PA Set AN/UIQ-10.

Amplifier, Audio Frequency, AM-6842/UIQ-10 (Figures 4 and 5) is a welded aluminum enclosure approximately 12 inches wide, 7 inches high, and 5 inches deep. The bottom surface is an interface for any one of the various Type 1 Army batteries (but not all these batteries are necessarily suitable for operating the equipment). The top surface is a finned heat-radiator to dissipate the heat produced by four power transistors. On the left side, connectors are provided for low-level signal and control interconnections; power input (other than battery) and speaker connectors are on the right side. The unit is completely closed and gasketed for immersion resistance. Access to the interior is provided through a removable cover on the back surface. Two printed circuit boards contain all except a few large chassis-mounted electrical parts. One circuit board hinges up for ease of access while still connected, or unplugs for replacement. A smaller board mounts the driver circuitry associated directly with the main power transistors; this board is semi-permanently mounted next to those transistors. The amplifier unit attaches to its mounting with four quick-disconnect fasteners.

Control, Amplifier, C-8967/UIQ-10 (Figure 6) is a welded aluminum enclosure approximately 8 inches long, 5 inches high, and 2 inches thick. It has a clip which enables it to be carried on the user's web belt in operation, and it contains all the operating controls for Public Address Set AN/UIQ-10. When it is mounted on the belt, all controls are on the top surface and visible to the operator. Microphone and other inputs face to the right hand side, while the interconnection to the amplifier unit comes off the left hand surface of the unit. Controls and connectors are guarded from accidental physical damage by protective flanges, and the control unit can be secured to the amplifier for carrying. All active circuitry is contained on a hinged printed circuit board which unplugs for replacement.

Functional Description

The Public Address Set accepts speech input to a microphone and amplifies it to a level audible at considerable distances. Principal features are high efficiency, light weight, and the provision for man-pack portability. There are three major functional subdivisions: the control and audio preamplifier circuits, the power amplifier circuitry, and the loudspeaker units.

<u>Control and Preamplifier</u>. This circuitry is contained in Control, Amplifier, C-8967. Inputs are accepted from an M-80/U microphone, a field telephone, a tape recorder, or a radio receiver. Two inputs can be accommodated at one time and mixed in the input circuitry. Volume control is provided, and amplification of the signal level required by the amplifier circuit (approximately 8 volts RMS).

The alarm signals are generated in this circuit group, consisting of a

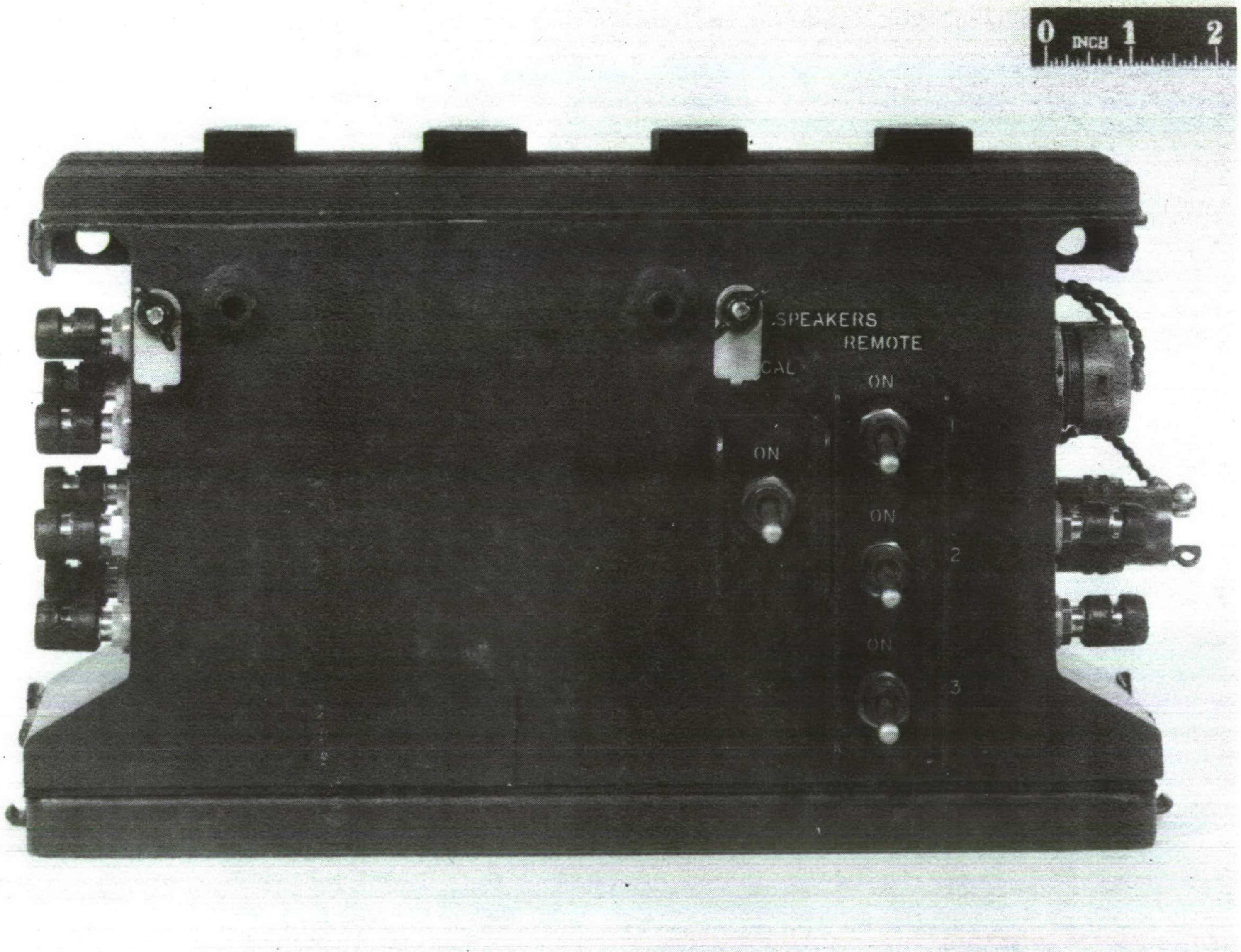

Figure 4. Amplifier, Audio Frequency, AM-6842(XLW-1)/UIQ-10 Front View

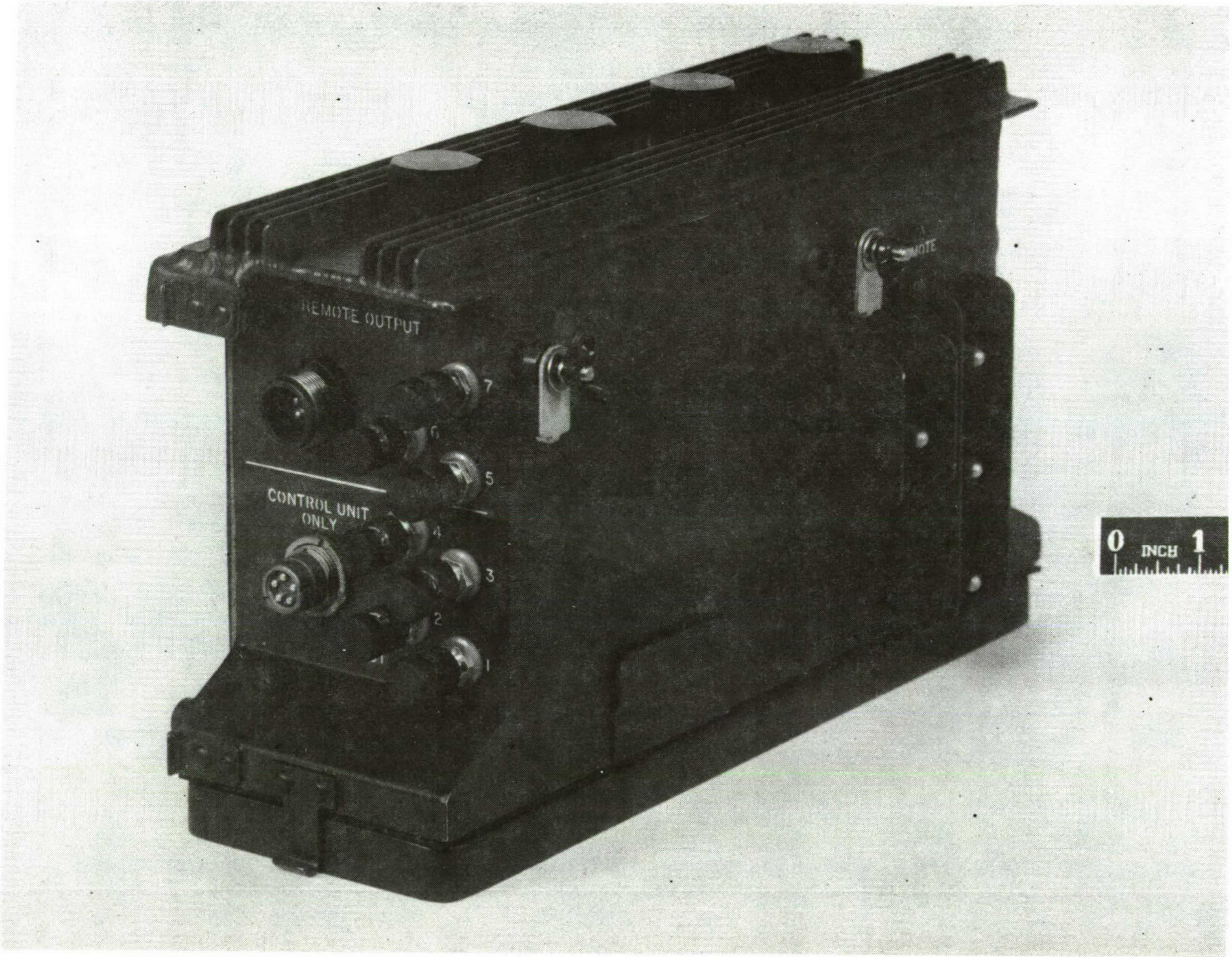

Figure 5. Amplifier, Audio Frequency, AM-6842(XLW-1)/UIQ-10 Three Quarter View

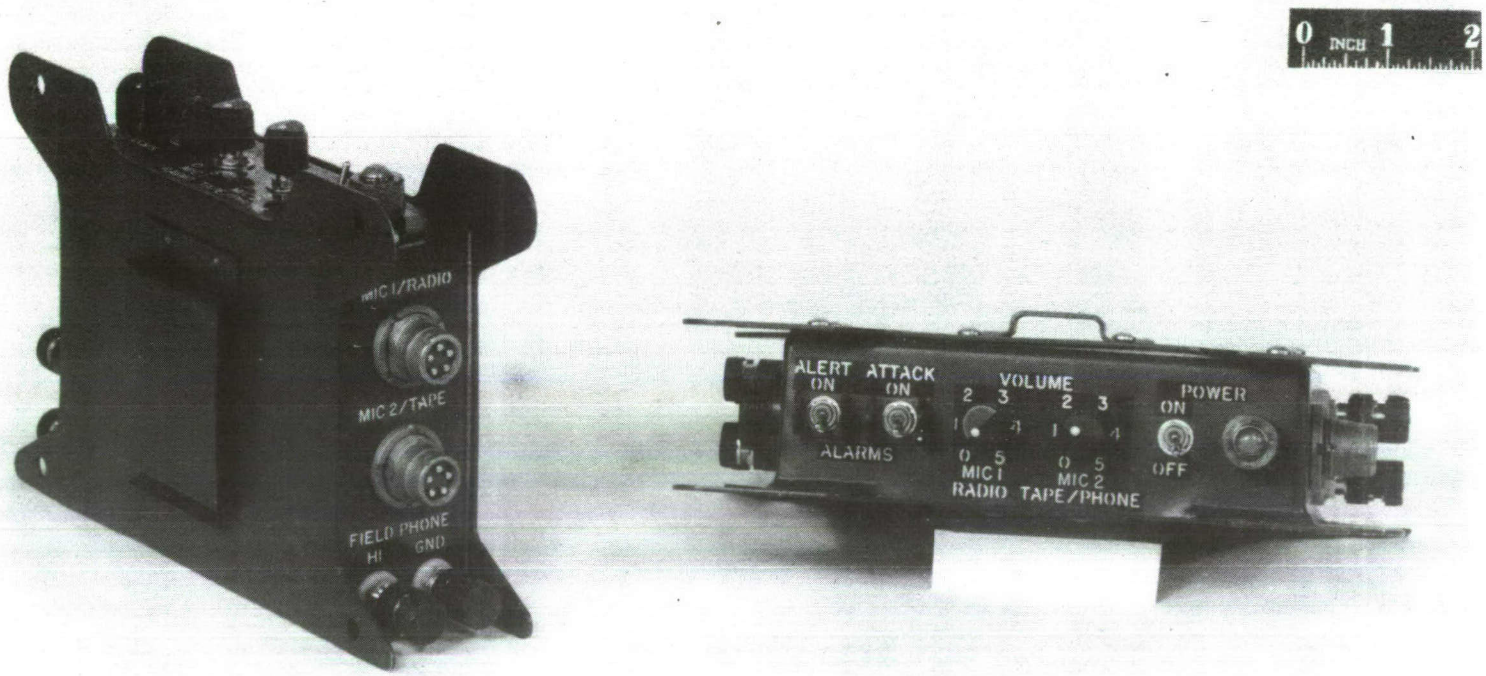

Figure 6. Control, Amplifier, C-8967(XLW-1)/UIQ-10

continuous audio tone for the ALERT warning or a sawtooth wobbulated signal for the ATTACK warning. These are controlled by toggle switches with the ATTACK alarm having override capability.

Amplifier Circuits. This functional group comprises the major active circuit elements of the PA Set, and is contained in Amplifier, Audio Frequency, AM-6482. The audio frequency signal from the control/preamplifier circuit is converted by means of pulse-width modulation techniques to a high-power audio output capable of driving a low impedance load. The signal is buffered and inverted to provide two audio signals 180 degrees out of phase which are applied to the pulse-width modulator along with a clock signal at approximately 50 kHz. The modulator develops two binary trains which, when properly buffered, switch the output power transistors, which are configured in a bridge connection with a balance output to the load. Normal full load is four loudspeakers in parallel, each 8-ohms impedance.

Power control circuits permit remote control of the system power from the control unit and provide electronic over-current and over-voltage protection, and protection against reversed polarity supply voltage.

Signal and control lines to the amplifier circuits from the control unit are carried in a four-conductor cable, 100 feet long.

Loudspeaker Units. A total of four loudspeakers are provided, any or all of which can be connected across the output power bridge to receive the balanced pulse-width modulated (PWM) binary signal. The integrating effect of the loudspeaker converts the PWM signal into a replica of the original audio signal. Each loudspeaker has a power rating of 75 watts, adequate to handle the full output voltage swing produced by the amplifier unit. A detailed description of the theory of operation is given in Appendix A.

Electric Characteristics

Typical values for the major performance parameters of the Public Address Set are listed below. Unless other wise indicated, all parameters are given for the standard test condition:

Ambient Temperature +25°C
Input Supply Voltage +28 volts DC
Dummy Load 2 ohms resistive
Audio Signal Frequency 1 kHz

1. Supply Voltage Range.

Nominal battery source	:	+24 volts D.C.
Norminal vehicular source	:	+28 volts D.C.
Operating range	:	+20 to +32 volts D.C.

2. Supply Current Drain. Typically 10.5 amperes D.C. at 250 watts output; approximately 600 milliamperes D.C. at no output.

3. Audio Input Sensitivity.

Microphone Inputs	:	10 millivolts RMS
Tape or Radio Input	:	100 millivolts RMS
Field Phone Input	:	100 millivolts RMS

4. Power Output. Typically 250 watts at 15% distortion.

5. Efficiency. Typically 85% at 250 watts output.

6. Distortion. Typically 15% at 250 watts output, at 450 Hz, 1000 Hz, and 3000 Hz.

7. Frequency Response. Within $\pm$ dB of 1 kHz level from 450 Hz to 3000 Hz.

Airborne Configurations

In the past, in order to generate high sound power for airborne installations, a large cluster of many 75 watt horns were mounted on a plate external to the aircraft. This approach was also attempted in the present project and some sound power measurements showed why this is unsatisfactory. A speaker assembly from PA Set AN/UIH-6, which consists of four separate 75 watt horns clustered together, was compared with a University 4A4L Super Power Speaker which uses four 75 watt drivers working into a single sound chamber driving a single horn. Also three AN/UIQ-10's (twelve separate 75 watt horns) were compared with a University B12P Super Power Speaker which uses twelve 75 watt drivers working into a single sound chamber driving a single horn. The sound power of the 4A4L speaker was 3db higher than the UIH-6 speaker assembly when driven by the same signal. The B12P speaker provided 10db higher sound power than the three AN/UIQ-10's. The University horns had the added advantage that they could be trained a limited amount in azimuth and elevation and thereby be aimed at the target and remain on it a longer time.

A prototype airborne installation was configured of three AM6482/UIQ-10 Amplifiers, one C-8967/UIQ-10 Control and a B12P Speaker (Figure 7). This 900 watt system, designated AN/AIQ-2, was installed in a UH-1 helicopter (Figure 8). The azimuth swivel is spring loaded against the pressure of the wind stream. A seat is provided so that the operator may train the unit using his feet and hands.

A smaller, 300 watt system (undesignated) using one amplifier and a 4A4L speaker was configured for the OH-58 helicopter (Figure 9). This system can also be trained in azimuth and elevation.

In early development tests of the airborne systems, audio oscillation and distortion problems were encountered when a tape recorder or the aircraft intercom was used as an input to the amplifiers. The problem was found to result from the presence of ground loops and too high an input signal. In the case of the intercom, the problem was solved by using transformer isolation and attenuation. A 7 to 1 stepdown transformer (from the 600 ohm intercom line to 12 ohms at the amplifier input) and a 560 ohm series resistor at the transformer secondary were built into a cable for use with the aircraft

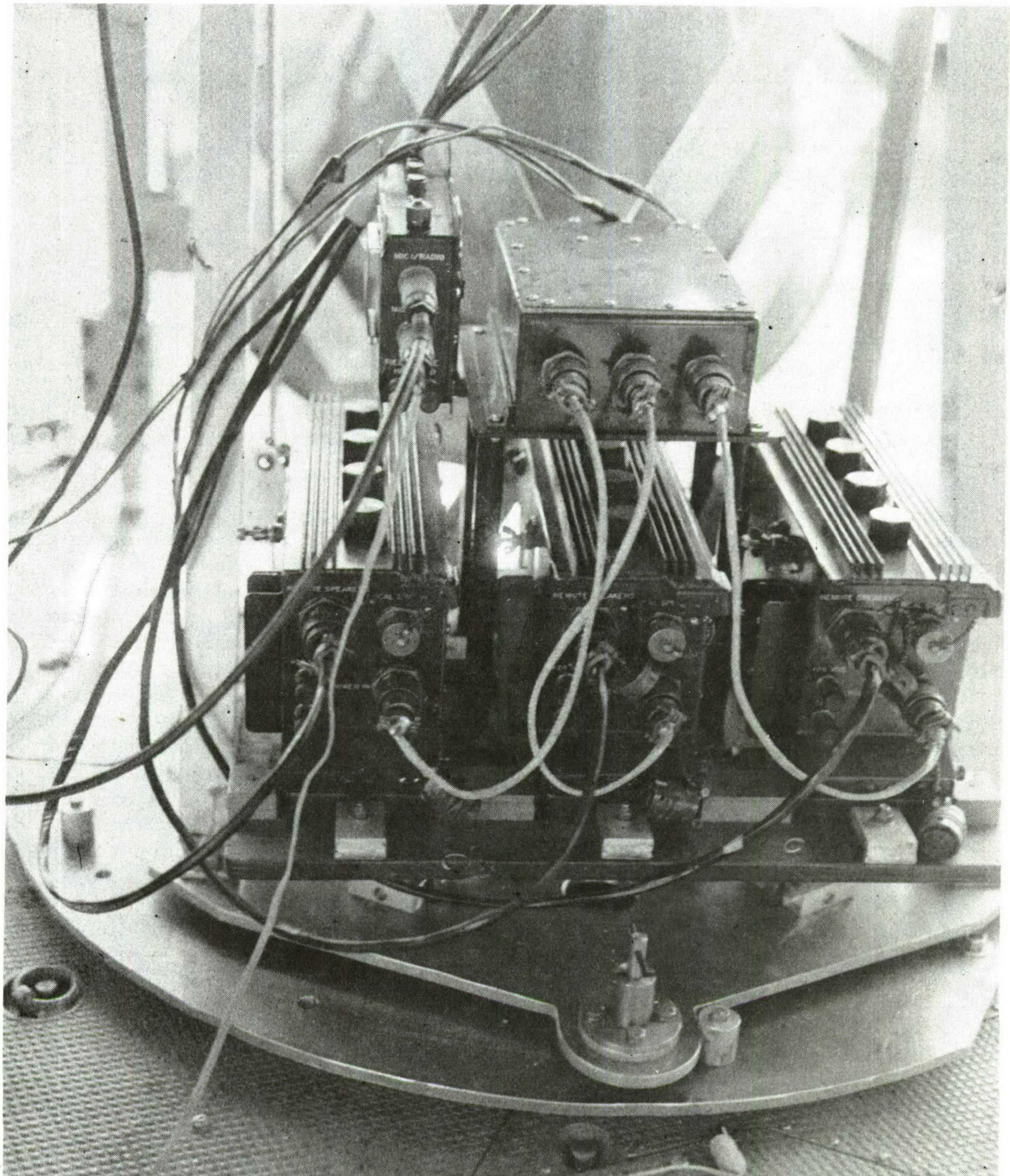

Figure 7. Electronic Components of 900 Watt Airborne Public Address System, AN/AIQ-2 Shown Mounted in Aircraft

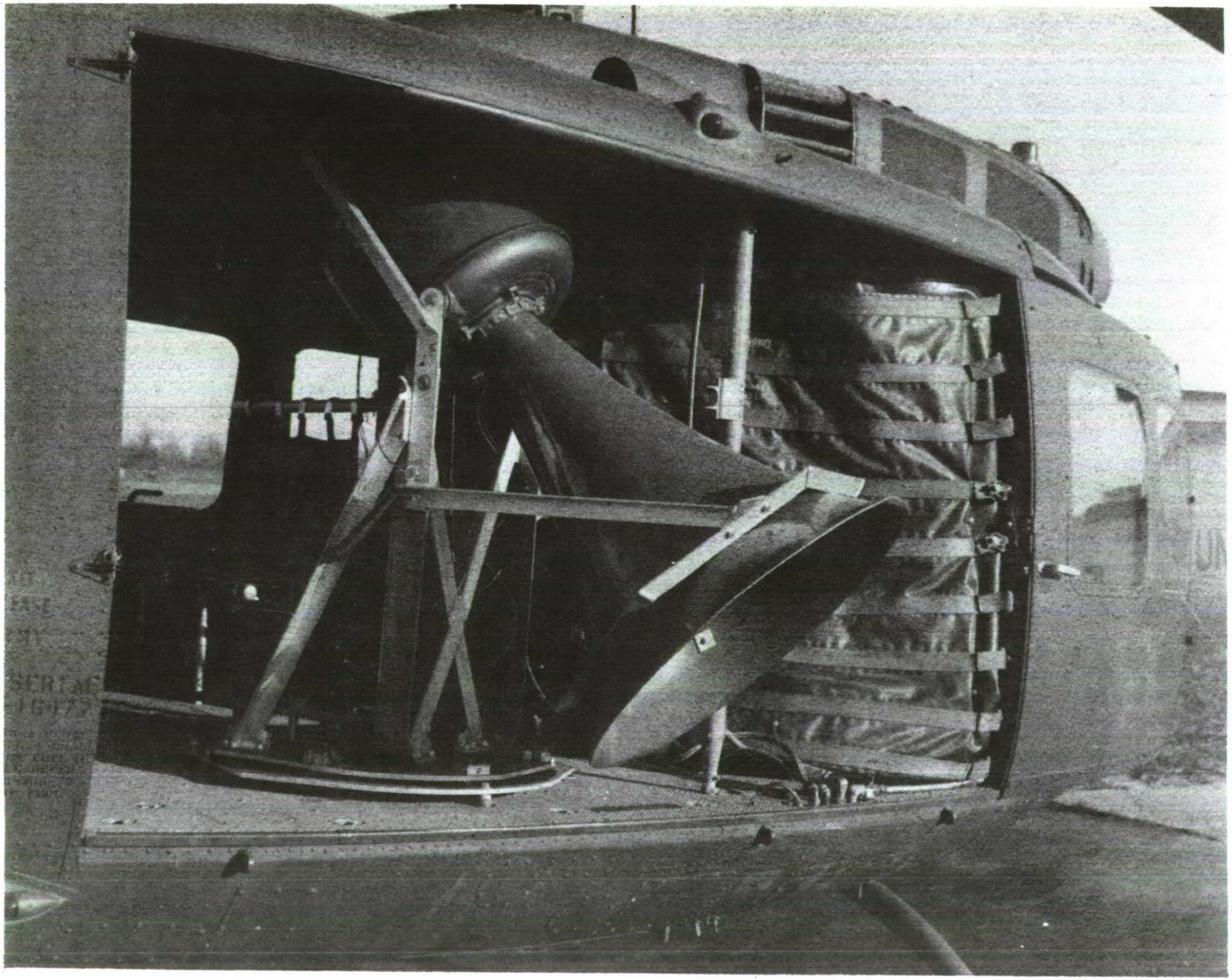

Figure 8. External View of 900 Watt Airborne Public Address System, AN/AIQ-2 Horn Shown on Swivel Mount

Figure 9. 300 Watt Airborne Public Address System Shown Mounted in OH-58 Helicopter

intercom. For use with any of the tape recorders which might be employed by users, special level control and monitoring units were designed. These are shown at the bottom of Figure 10. They permit the input signal to the amplifier to be monitored and adjusted to provide clear amplification. The power dissipation unit shown at the top of Figure 10 is substituted for the loudspeakers during test and adjustment of the system. It permits the system to operate "normally" at full power during test and adjustment without danger of hearing damage to the operator. In addition it provides a meter indication of system power output.

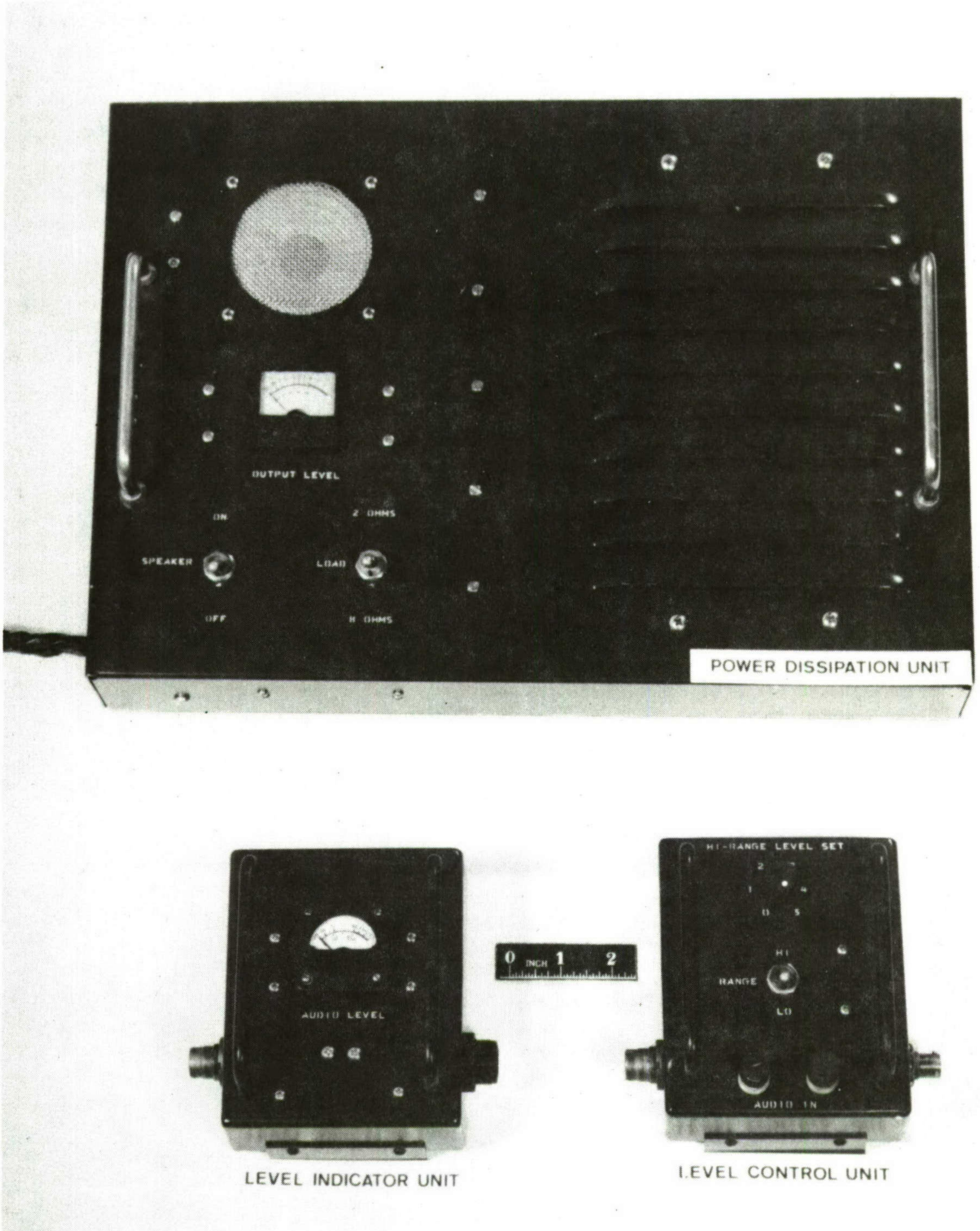

Figure 10. Top: Dummy Load/Output Monitoring Unit
Bottom: Input Level Control & Monitoring Units

TEST PROCEDURES AND RESULTS

Engineering Tests

The Public Address Set is designed for a broad range of environmental conditions. It is intended to operate at temperatures from -40°C to +65°C, and in humidity up to 94% RH. Since it is intended for field use under tactical conditions, the set is designed to withstand the effects of shock, vibration, drops, submersion, salt atmosphere, sand and dust, and rainfall.

The amplifier, AM-6842 and control amplifier, C-8967 of the prototype AN/UIQ-10 were subjected to the temperature test requirement of MIL-E-16400 for Class 1 Equipment as well as the vibration test required by MIL-STD-810A, method 514.1, Equipment Class 7. The units were tested for distortion and efficiency before, during, and after the temperature test and before and after the vibration tests. Details of the test procedures and results are given in Appendix B. Although minor defects in the system showed up during the tests, after they were corrected the system performed satisfactorily under all test conditions.

In addition, an investigation was performed to measure the RFI/EMC characteristics of the AN/UIQ-10. It was found that the system would not meet the requirements of MIL-STD-461 without greater care in shielding all components. Details of this investigation are given in Appendix C. In practice, during operational tests of the airborne systems, no problems of interference with radio communications or navigation aids were reported.

Operational Tests of the AN/UIQ-10 by the US Marine Corps

Units of the Fleet Marine Force, Atlantic, conducted extensive operational tests under simulated combat conditions to determine the suitability of Public Address Set AN/UIQ-10 for general Marine Corps use and to determine a basis-for-issue. Eight systems were used in these tests. Details of the test procedures, conditions, and results are given in a report entitled "Final Report of High Powered Sound System AN/UIQ-10 (XLW-1)," CMC Project 43-69-14 by the Development Center, Marine Corps Development and Education Command, Quantico, VA dated 1 Mar 1973. It was concluded that the system met the requirements of the Marine Corps; that it provided substantial improvement over sound systems presently in use within the Marine Corps in performance, efficiency, and ease of operation; and that the system will form the basis for all future public address systems within the Marine Corps. As a result, the Marine Corps is standardizing the AN/UIQ-10 and has initiated a production contract.

Operational Tests of the AN/UIQ-10 by the US Army

Two AN/UIQ-10 Public Address Sets were evaluated by the 92nd Psychological Operations Company (Tactical) at Ft Bragg, NC. The systems were tested in comparison with the AN/UIH-6 Public Address Set in field training exercises and in support of garrison training and maintenance programs. Detailed results are given in Appendix C. In general, it was concluded that the AN/UIQ-10 was superior for reasons of performance, transportability, quality of sound,

ease and flexibility of employment, and long battery life. Special features such as the built-in attack and alert alarm signals were considered to be very useful.

Test of the Airborne Public Address System

The 900 watt Airborne Public Address Set, AN/AIQ-2, was tested at the Marine Corps Base, Quantico, VA. For the most part, the aircraft (UH-1H helicopter) was flown in circular orbits about a group of listeners on the ground. Details of the test are given in the previously cited (Sec 3.2) Marine Corps Test Report (pages A-21 and A-22). Under the most stringent test conditions with the aircraft flying a 2000 meter diameter orbit at an altitude of 5000 feet (a slant range of approximately 6000 ft), the listeners on the ground evaluated the system as having good volume and very good intelligibility and clarity. It was concluded that the airborne system is reliable, flexible, and of sufficient tactical importance to warrant its acceptance. The airborne configuration provides the Marine Corps with a capability previously unavailable and will be very useful in riot control and psychological operations.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The development objectives for Public Address Set AN/UIQ-10 have been met.

2. In operational tests by Marine Corps and US Army units, the system was judged to be superior to all other systems available to the users.

3. The Marine Corps has standardized the AN/UIQ-10 and has begun production.

4. The airborne versions of the system provide a previously unavailable capability. The Marine Corps has concluded that the system will be very useful in riot control and psychological operations.

Recommendations

1. It is recommended that the US Army standardize the AN/UIQ-10 for use as a high powered, man portable, public address set.

2. The technique of using single horn speakers in airborne public address systems should be incorporated in Army developments in this area.

APPENDIX A

THEORY OF OPERATION

PUBLIC ADDRESS SET AN/UIQ-10

APPENDIX A

THEORY OF OPERATION - PUBLIC ADDRESS SET AN/UIQ-10

(See Block Diagram, Figure A-1).

Operation of the system begins with actuation of the POWER switch in the Control Unit which activates the power control circuit located in the Amplifier. Assuming that the supply voltage and load current are not excessive, this circuit provides voltage to the other circuit elements in both Amplifier and Control Unit.

Audio inputs all go to the input circuits in the Control Unit where they are mixed together onto one signal line. Volume control is also provided in the input circuitry.

The pre-amplifier circuit provides both voltage and current amplification for the audio signal. The maximum output level is approximately 8 volts RMS. Output impedance is about 600 ohms.

Alarm signals are generated by the astable multivibrator circuit which produces a square-wave signal. When the ramp generator is energized, the frequency of the square-wave is varied by the ramp signal to produce the ATTACK alarm. When the ramp generator is not active the square-wave is a constant frequency for the ALERT signal.

The audio signal into the Amplifier Unit first passes through a simple low-pass filter (cut-off frequency 4 kHz) and then goes through two precision inverting amplifiers having unity numerical gain. They produce two buffered audio signals exactly 180 degrees out of phase with each other, which are directed to the comparator circuit.

The clock generator provides the other input to the comparator, a sawtooth waveform with a repetition rate of about 50 kHz. This is the sampling waveform which provides the time base for the pulse-width modulation.

The comparator circuit is the heart of the entire public address set because it is this circuit which converts the audio signal into a binary pulse-width modulated signal which controls the high-power output bridge. Since the audio signal is restricted in band width to about 4 kHz, its amplitude changes relatively slowly compared to the sawtooth clock waveform. To simplify the explanation of how the pulse-width modulator functions it is desirable to consider how it would function if a series of D.C. voltage levels replaced the audio signal. This concept is illustrated in Figure A-2, where (a) shows a level, representing close to the maximum positive audio peak, superimposed on the clock waveform. The comparator output signal is shown by the binary waveform just below. The comparator output is "high" (more positive level) whenever the audio level is more positive than the clock sawtooth. In this example it is high the majority of the time.

The case which occurs when the audio level is at the mid-point is shown in (b) of the same figure. The output is now a square wave, in each state 50% of the time.

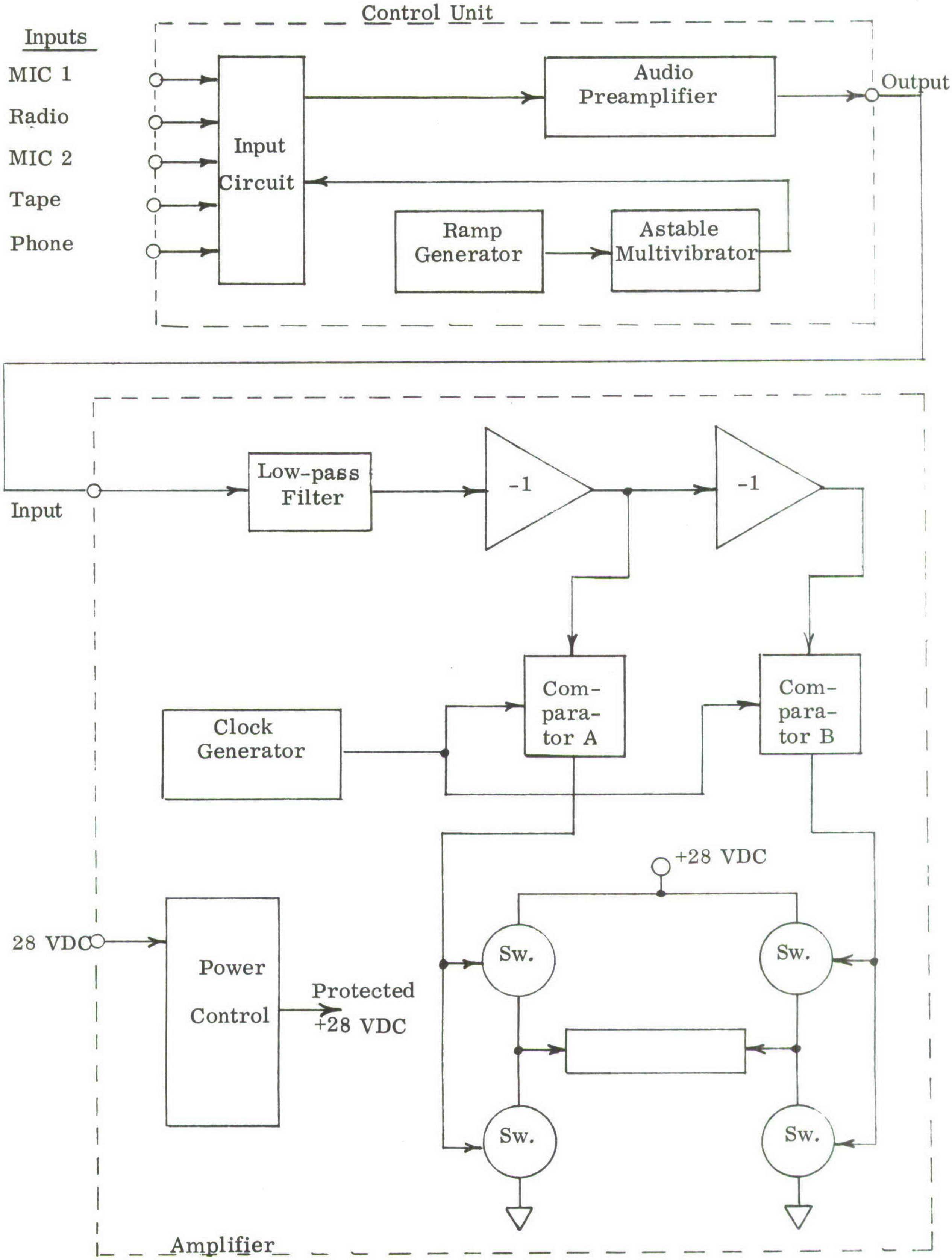

Figure A-1. AN/UIQ-10 Simplified Block Diagram

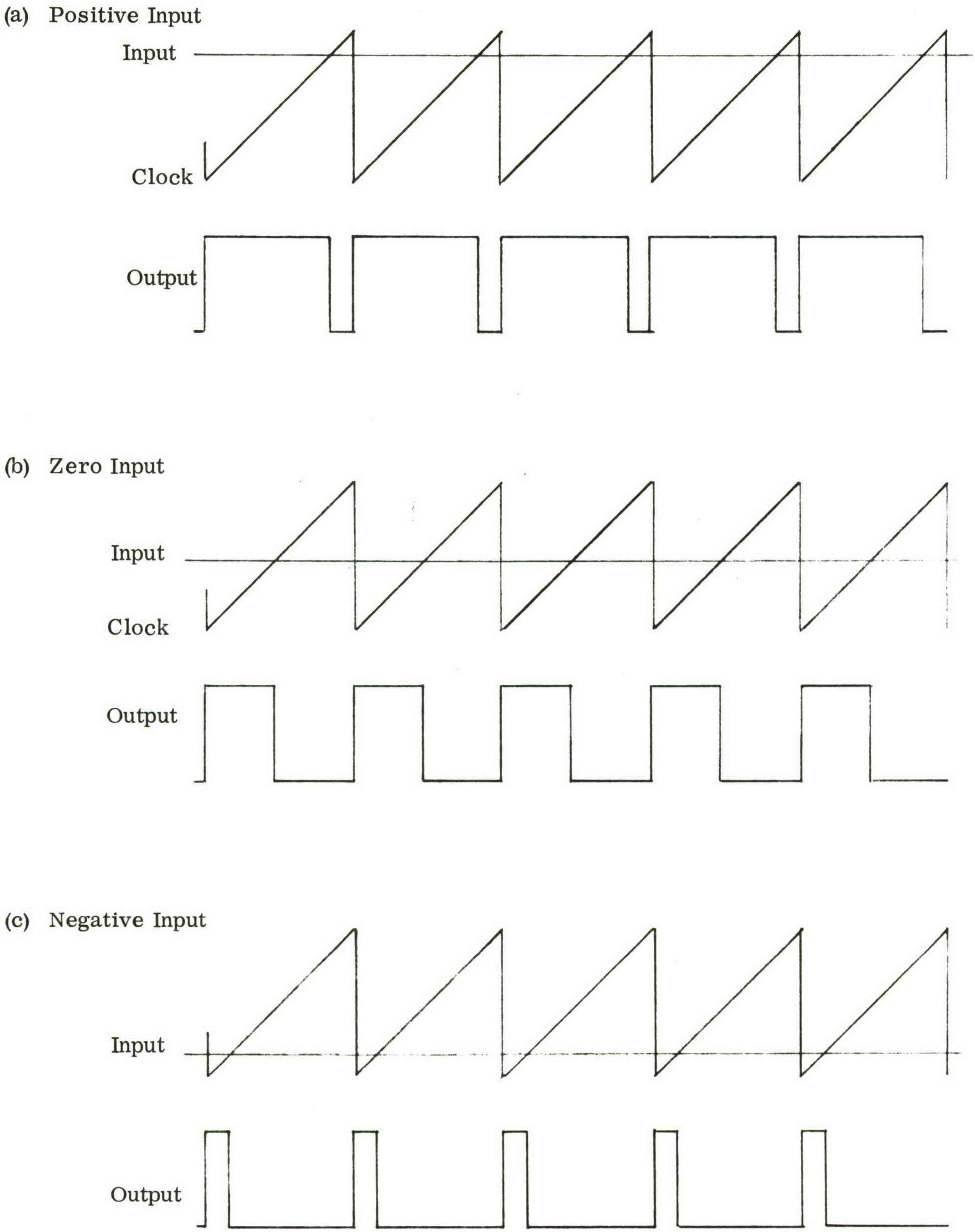

Figure A-2. Comparator Waveforms for D.C. Input

When the audio level is near the most negative peak value, as shown in (c), the binary output signal is high only for short time intervals. It is obvious that if the audio input level becomes sufficiently negative, the comparator output will stop switching and stay in the "low" state for the duration of the condition, which amounts to saturation of the modulator and corresponds to peak clipping. The same condition naturally occurs on the positive audio peaks as well.

Each of the two identical comparator circuits operates as described, but comparator B is receiving the inversion of the audio input supplied to comparator A, so the outputs will be different at any given time.

The comparators each drive one-half of the output bridge circuit in such fashion that when comparator A output is low the voltage output of that half of the bridge is high (+28 volts, approximately) and when the comparator output is high the bridge section output is low (near ground). For intervals when the input audio is above the mid-point level, the current in the load connected across the bridge will be positive and either I_{max}, where $I_{max} = \frac{V\ supply}{R\ load}$, or zero; the ratio between these two states is dependent on the instantaneous audio level. When the audio input is below the mid-point level, load current is negative and similarly switches between I_{max} and zero in proportion to the negative audio level.

One important feature of this dual-comparison modulator and balanced output bridge is the fact that for zero audio input there is essentially no net load current in either direction. One way of visualizing this effect is to realize that while both sides of the bridge are switching between the supply voltage and ground at the clock rate, they are switching "in phase" and thus there is no voltage difference across the load.

The pulse-width-modulated signal across the load is binary, with relative duration and polarity of the current the only variables. When the load is a loudspeaker coil, this switching waveform is effectively integrated by the basic low-pass nature of the load device. The sound output from the speaker is a faithful reproduction of the input audio signal.

The primary advantage of the pulse-width-modulated Public Address Set lies in the fact that the output transistors and their drivers are always either saturated or cut-off and consequently dissipation in these elements remains low under all conditions of audio output level from zero to full power. Output circuit efficiency is high across the full operating range, so that fixed losses in low-level amplifier and power control circuits become important at the lower output levels.

DETAILED CIRCUIT ANALYSIS.

To follow this analysis of the circuits in the Public Address Set, refer to the schematic diagrams, Section VII of this manual. The descriptions given here assume a certain familiarity with common circuit types and an understanding of electronic components, including semiconductors.

a. General. The Public Address Set is composed for the most part of straight-forward circuit combinations. It is basically an open-loop device, with no large feedback paths: the feedback loops that do occur are around a single circuit and are easy to follow. All the integrated circuit amplifiers are one type, the Fairchild 741, which is a differential-input operational amplifier with internal frequency compensation. Pin 2 is the inverting input, pin 3 the non-inverting.

b. Power Control Circuit (See schematic, sheet 2). The supply voltage to the operating circuits in the unit is applied when relay K1 is activated. In the absence of any trouble, this occurs when a ground is applied to J1-C or E4, crossing A1Q2 and A1Q15 to conduct. An input voltage in excess of approximately 33 volts DC causes break down diode A1VR3 to conduct, which switches A1Q1 into conduction, cuts off A1Q2 and A1Q15, and allows K1 to deenergize.

In normal circumstances the output of voltage comparator A1A3 is near ground level. Network A1Z1 is an equal-arm precision voltage divider and the current drawn by A1R14 and A1R36 biases the comparator in the direction to keep the output low. However, if excessive supply current is drawn through shunt R1, the voltage difference between A1Z1-1 and A1Z1-5 becomes large enough to overcome the initial offset provided by A1R14 and A1R36. When the voltage at pin 2 of A1A3 goes negative with respect to pin 3, the output of A1A3 goes positive, turning on A1Q1 and deenergizing relay K1. Resistor A1R15 provides a small amount of positive feedback to latch the comparator and prevent oscillation. Similarly, A1R20 provides a latching effect when A1Q2 is cut off. Diodes A1Cr1, A1CR3, A1CR10 and A1CR12 are provided to block conduction in case the wrong polarity voltage is applied to the equipment. They prevent activation of the power relay and also protect some of the power control circuits from damage.

c. Audio Input Circuit (See schematic, sheel 1). The input circuit allows use of various signal inputs of different levels and controls the overall gain with a minimum number of variable components. Note that the volume control potentiometers R1 and R2 act as voltage dividers for the

microphone inputs applied to J1-D or J2-D, while they attenuate the other input signals by acting as variable-resistance shunt elements in conjunction with other series resistors. Diodes A1CR1 and A1CR2 function as voltage limiters to prevent the ringing signal from a field telephone from damaging the amplifier. Terminals A1E3 through A1E5 can be jumpered as shown, E4 to E5, to permit volume control R1 to control the level of the alarm signals. They can also be jumpered E4 to E3 at the user's option, to provide full alarm output with no volume control possible.

d. Preamplifier (See schematic, sheet 1). The preamplifier consists of two operational amplifier modules cascaded to provide sufficient fixed audio gain to boost microphone signals to the level required by the Amplifier Unit. They are both D.C. biased at one-half the supply voltage.

e. Alarm Generator Circuits (See schematic, sheet 1). The basic source for the alarm signals is the astable multivibrator circuit involving A1Q3 and A1Q4. This is a conventional circuit which produces a square-wave output at the collector of each transistor. Output frequency can be varied over a 2:1 range, or more, by changing the voltage applied to the base resistors A1R30 and A1R31.

When only the ALERT alarm switch is on, voltage is applied to the multivibrator and regulated at about +6.8 volts DC by A1VR1. The frequency controlling voltage is fixed by voltage divider A1R27, A1R28, and A1R26 and produces a constant-frequency tone from the multivibrator.

Whenever the ATTACK alarm switch is on, voltage is supplied to the multivibrator through diode A1CR3 and also to sawtooth generator A1Q1, a unijunction transistor circuit. The voltage across A1C10 rises at a nearly linear rate until it reaches a level set by the voltage at base 2 of A1Q1. At that point A1Q1 conducts strongly from emitter to base 1 rapidly discharging A1C10 through A1R24. Once the capacitor is discharged, A1Q1 returns to the non-conducting state and the cycle repeats. The repetition rate with the constants shown is about 2 Hz. Emitter-follower A1Q2 buffers the sawtooth waveform and applies it to the frequency-controlling input of the multivibrator where it causes a frequency shift in a linearly rising tone following the sawtooth pattern. This "yelp" or "whoop-whoop" sound is very distinctive and attention-getting as a warning signal.

Terminals A1E1 and A1E2 are provided for test purposes. They permit breaking the connection between the sawtooth generator and the multivibrator to check the operating frequency range of the multivibrator under controlled conditions. The frequency-shifting signal is nearly impossible to measure without this capability.

f. Inverting Amplifier (See schematic, sheet 2). These two circuits, based on modules A1A1 and A1A2, are operational amplifiers connected to have a precise numerical voltage gain of unity. Together they provide the audio and inverted audio signals needed by the comparators. They are D.C. biased to correspond to the mid-point of the sawtooth clock signal, through use of

A1VR1 and the associated resistors. Variable resistor A1R9 allows introducing a slight offset into the audio output to improve modulator performance.

g. Clock Generator (See Schematic, sheet 2). The clock generator is built around unijunction transistor A1Q11, and is basically similar in operation to the circuit described in paragraph (e) above. There are certain differences: the operating frequency is about 50 kHz; capacitor A1C11 discharges to a reference voltage set by A1VR2 instead of to ground; and the charging current is supplied by constant-current generator circuit A1Q12 for improved linearity. The sawtooth output is buffered by emitter-follower A1Q14 before going to the comparators.

Transistor A1Q13 functions as a "clock killer" when it is switched into the conducting state; it stops the clock oscillation and clamps the clock signal line near ground. This action in turn stops the switching of the output bridge transistors and makes both sides of the load assume a steady-state condition close to ground potential. The purpose of all this is to provide quick-acting electronic protection when an over-current is sensed. This circuit effectively disables the high power circuits in microseconds, compared to the 10 to 15 milliseconds required for relay K1 to drop out after it is deenergized. The clock killer is activated when the collector of A1Q2 goes to its "high" state.

h. Comparator Circuit (See schematic, sheet 2). The complete comparator circuit, or pulse-width modulator, actually consists of two identical voltage comparators. One of these is made up of A1Q3 through A1Q6 and associated components. The comparison is really done by A1Q3 as it switches state, depending on whether its base-emitter junction is forward-biased or reverse-biased at a given instant. Transistor A1Q5 is just an emitter-follower buffering the audio input signal, while A1Q6 functions as a constant-current source. Transistor A1Q4 acts as a current amplifier for the output of A1Q3. When the clock level is more positive than the audio signal level, A1Q3 conducts and A1Q4 also conducts more heavily. When the clock level is less positive than the audio, both transistors are non-conducting. This binary current waveform is the output of the comparator to the bridge output circuit.

i. Output Bridge Circuit (See schematic, sheet 2). The power switching output bridge consists of two identical halves, each connected to one end of the loudspeaker or speakers which make up the load. Consider the bridge-half driven by the comparator output signal from A1TP4, and composed of A1Q4, A2Q5, A2Q6, Q3 and Q4. The heat-sink-mounted switching transistors Q3 and Q4 are connected in the familiar pull up/pull down arrangement sometimes called a "totem pole" configuration. When one transistor is switched on into saturation the other is switched off into cut-off. Conduction of the output transistor in the comparator cause A2Q4 to switch on, cutting off A2Q6. Transistor A2Q5 functions as a constant-current source for the collector of A2Q4. When A2Q4 is saturated, its collector is near the supply voltage. Q3 acts as an emitter-follower, so its emitter (which is the output of the half-bridge) is also pulled up close to the positive supply voltage. At the same time, A2Q6 is not conducting (see above) and resistor A2R9 ensures cut-off of Q4.

The opposite conditions occur when the comparator output stage is not conducting. Then A2R6 cuts off A2Q4, which means that the A2Q5 current is diverted into turning on A2Q6. When A2Q6 is conducting, Q4 is driven into saturation and its collector pulled down near ground. The "low" condition at the base of Q3 cuts that device off and allows the Q4 pull-down to occur without restraint.

The operation of the other half of the bridge is similar. When driven by the pulse-width-modulated signals from the comparator, the output bridge is able to apply nearly the full supply voltage (supply voltage less the voltage drop across two saturated transistors in series) across the load in either direction. With a single +28 VDC supply, this circuit can provide the effect of an audio voltage swing of more than 52 volts peak-to-peak. Some typical bridge output waveforms are shown in Figure 4-3 to illustrate the concept. Switching signals A and B represent the two bridge output voltages with respect to ground. The A-B waveform is the voltage across the balanced load connected to the output terminals. Figure 4-3 (a) represents the condition for a negative peak on the audio output, while Figure 4-3 (b) shows the formation of a positive audio peak.

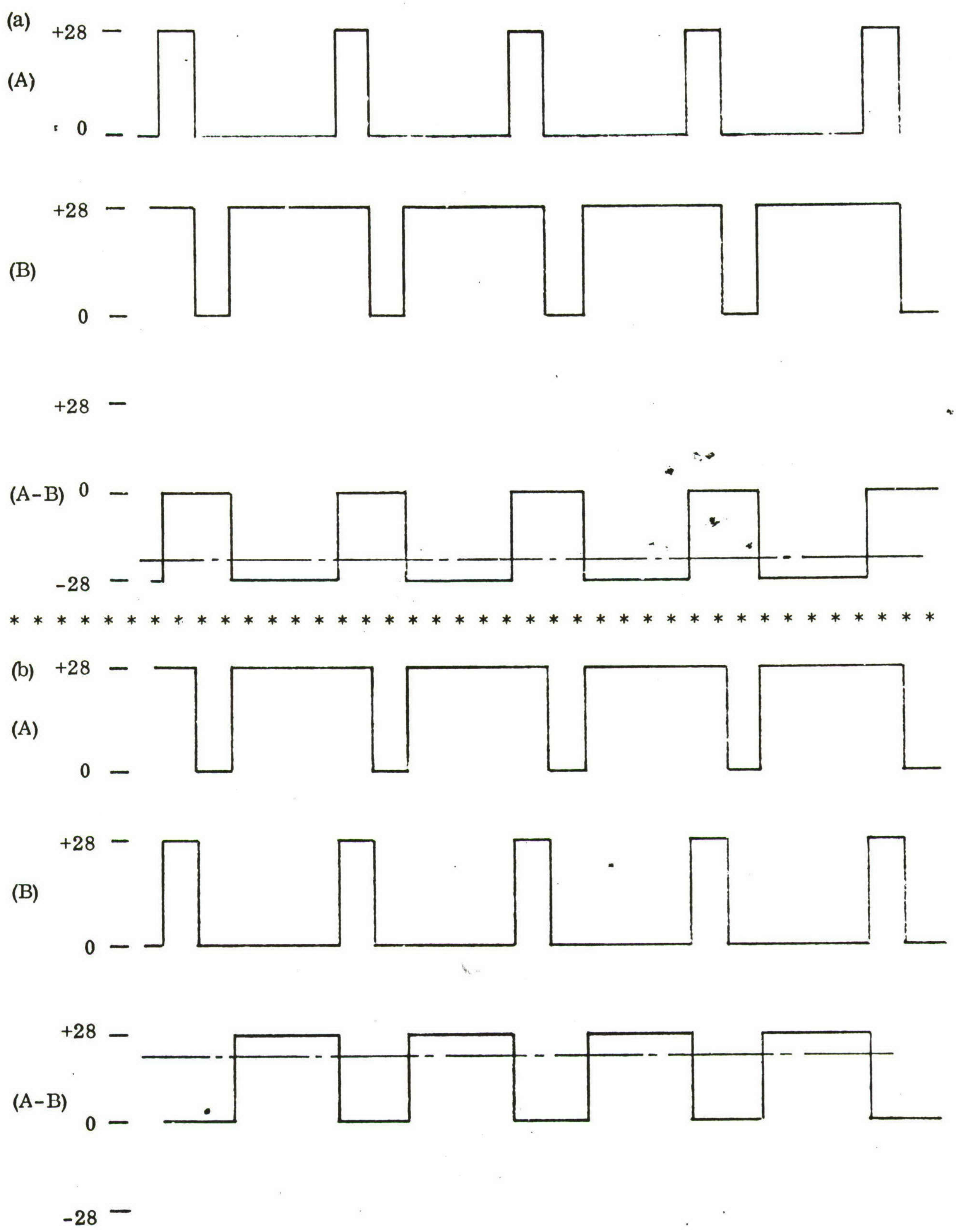

Figure A-3. Output Bridge Waveforms (illustrative only)

APPENDIX B

ENGINEERING TESTS OF PUBLIC ADDRESS SET

AN/UIQ-10

APPENDIX B

ENGINEERING TESTS OF PUBLIC ADDRESS SET AN/UIQ-10

The amplifier and controller of the prototype AN/UIQ-10 (Serial #P1) Public Address System were subjected to the temperature test requirement of MIL-E-16400 for class 1 equipment as modified for the tests done on the AN/UIQ-8 as well as the vibration test required by MIL-STD-810A method 514.1 Equipment class 7. The UIQ-10 was tested for Distortion and Efficiency before, during, and after the temperature test and before and after the vibration tests. An RFI/EMC investigation was also performed and is reported in Appendix C.

TEST PROCEDURES

1. Temperature Tests. The temperature test program consisted of the following steps.

a. The controller and amplifier of the AN/UIQ-10 were placed in the temperature chamber. The audio frequency generator, the power supply, the load, and the test equipment necessary to perform the distortion and efficiency tests (see Section 6.1.3) were placed outside the chamber and connected together and the electrical tests (distortion and efficiency) were performed.

b. The chamber temperature was reduced to -40°C and maintained for at least 24 hours. The electrical tests were performed periodically during the 24 hours and at the end of that period.

c. The temperature of the chamber was increased in steps of 10°C (30 minutes per step) until +65°C was reached. The electrical tests were performed at the end of each 30 minute step.

d. The temperature was maintained at +65°C for four hours. The electrical tests were performed at the end of this period.

e. The temperature of the chamber was decreased in steps of 10°C (30 minutes per step) until +25°C was reached. The electrical tests were performed at the end of each 30 minute step.

f. The temperature was maintained at +25°C for four hours. The electrical tests were performed at the end of this period.

2. Vibration Test. The vibration test program consisted of the following steps.

a. The distortion and efficiency tests (See Section 3) were performed prior to mounting the controller and amplifier on the vibration table.

b. The controller and amplifier were mounted on the vertical vibration table. A resonance search was made in the 5 to 500 Hz region. Any resonances found were dwelled on for 30 minutes at the amplitudes specified

by the following table:

Frequency Range (Hz)	D.A. (inches)	Acceleration -G's
5-12	.2 *	---
12-26	---	1.3
26-52	.036	---
52-500	---	5.0

* = limited by capability of the vibration machine

c. The equipment was vibrated at the levels given in step b. above for the time cycles given below. Each time cycle was performed three times.

Frequency Range (Hz)	Cycle Time
5 - 26 - 5	5 min
26 - 52 - 26	5 min
52 - 500 - 52	5 min

d. The equipment was examined visually for mechanical failure.

e. Steps b through d above were repeated for the major and minor horizontal axes.

f. The distortion and efficiency tests were performed at the end of the vibration tests.

3. Distortion and Efficiency Tests. The electrical test program consisted of the following steps.

a. The test equipment was setup in the manner shown in Figure B-1.

b. The oscilloscope gain (input to vertical output) was measured by connecting the input to a sinewave source of known RMS output and noting the vertical output level as displayed on the RMS volt meter.

c. The power supply was adjusted for 28V D.C.

d. The gain control on the AN/UIQ-10 was adjusted so that the output was 250 watts. This was calculated from the following formulas:

$$(\text{RMS Voltmeter reading}) \times (\text{scope gain}) = (\text{AN/UIQ-10 Voltage output})$$

$$\frac{(\text{AN/UIQ-10 Voltage output})^2}{(\text{Load Impedance})} = (\text{AN/UIQ-10 power output})$$

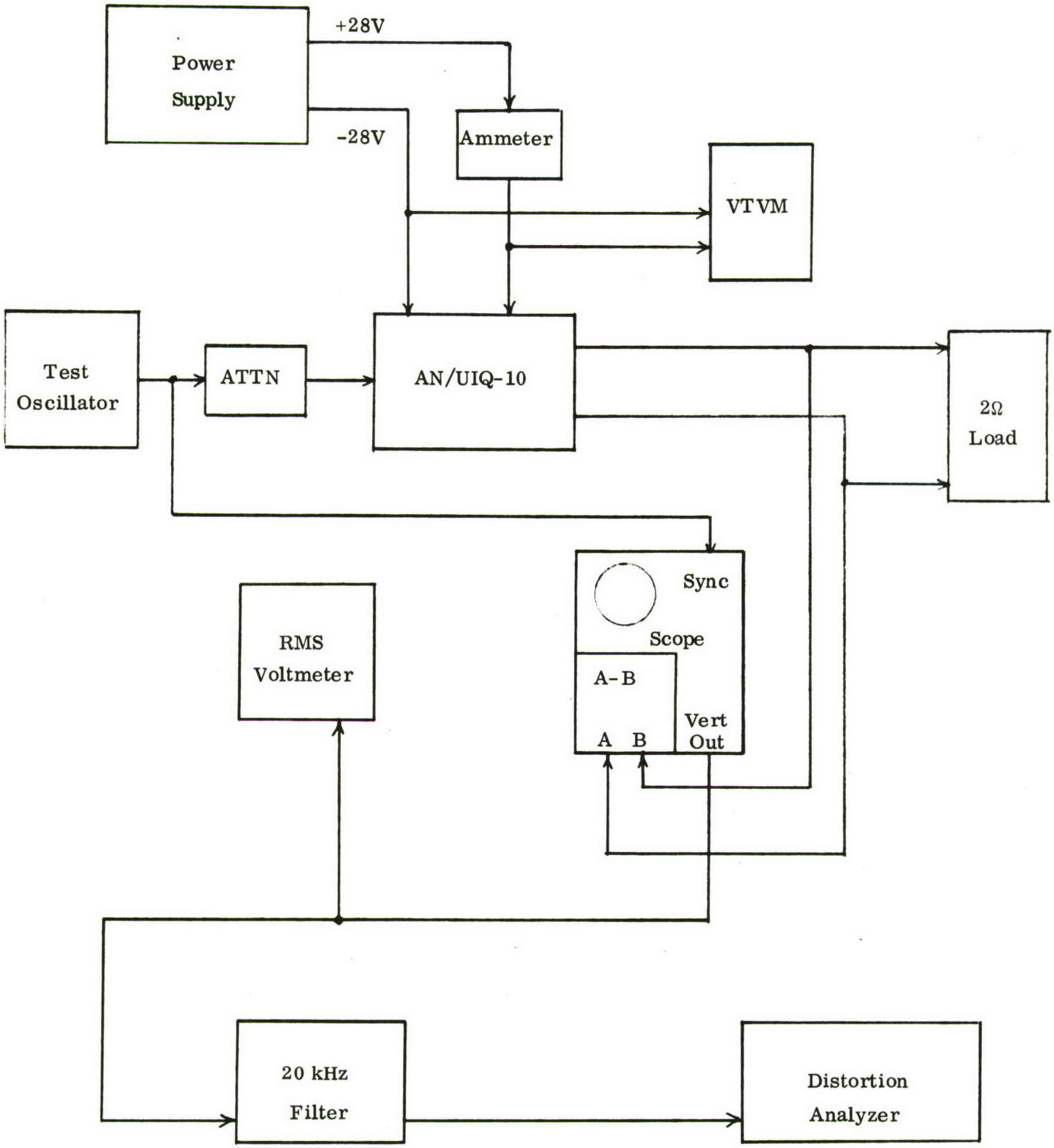

Figure B-1. Test Set-up for Distortion and Efficiency Tests

e. The distortion, in percent, was read from the distortion analyzer.

f. The efficiency was calculated using the following formulas:

(AN/UIQ-10 Power input) = (AN/UIQ-10 Voltage input) x (AN/UIQ-10 Current input)

$$\text{Efficiency} = \frac{\text{(AN/UIQ-10 Power output)}}{\text{(AN/UIQ-10 Power input)}}$$

TEST RESULTS

1. Temperature Tests. The results of the distortion and efficiency tests performed during the temperature cycling are shown on the attached data sheets. The primary results were:

a. Problems were encountered with the operation of the temperature chamber at -40°C and at +65°C. All of these problems were solved by manual operation of the chamber controls.

b. A problem of increased distortion was noted at +30°C and +40°C. This was traced to a loose connection on the audio input cable ground external to the UIQ-10. This was repaired and testing resumed with no further difficulties.

2. Vibration Tests. The results of the vibration testing and the electrical tests performed before and after the vibration test are shown in the attached data sheets. The primary results were:

a. The amplifier box failed the vibration test due to a crack in the case at the rosette weld for the relay bracket. This was due in part to the fact that the relay bracket was not flush with the case when the weld was made, resulting in the bracket and relay oscillating on the two pillars of weld material.

b. The relay bracket was redesigned, a stiffener plate was added, both were spot welded, and the vibration test repeated with no mechanical failure.

c. After the vibration tests the AN/UIQ-10 was found to operate only intermittently. This was traced to a transistor (Q7 in the amplifier, 2N3253) which had apparently suffered a random failure as a result of the vibration. This transistor was replaced and the electrical (distortion and efficiency) test repeated with the AN/UIQ-10 performing satisfactorily.

TEMPERATURE TEST DATA

Item under test: AN/UIQ-10 S/N P1

Test Conditions: Supply Voltage -28 Vdc, Audio input frequency -1 kHz, Scope gain conversion factor -13.3, Output Voltage -1.68 Vrms, Output Power - 250 watts,

Test Dates: 2 August through 4 August 1971

Time/Day	Temp °C	Current In A	Power In W	Distortion %	Efficiency %	Comments
10:45 am/2	-15	9.4	263	13.0	95.0	
11:30 am	-40	9.22	258	14.6	97.0	
1:00 pm	-43	9.25	259	14.4	96.6	Automatic control
2:00 pm	-45	9.25	259	14.0	96.6	of temperature
3:00 pm	-43	9.25	259	14.0	96.6	failed several
4:00 pm	-43	9.25	259	13.2	96.6	times during this
5:00 pm	-43	9.20	258	13.2	97.0	period requiring
7:00 pm	-43	9.20	258	12.5	97.0	manual override
10:00 pm	-41	9.20	258	13.0	97.0	to control
12:30 am/3	-42	9.30	260	14.0	96.0	temperature
2:30 am	-42	9.35	262	14.0	95.5	
6:00 am	-42	9.30	260	13.5	96.0	
8:00 am	-42	9.30	260	13.5	96.0	
10:45 am	-40	9.30	260	13.5	96.0	
11:22 am	-30	9.30	260	14.0	96.0	
11:52 am	-20	9.30	260	13.2	96.0	
12:22 pm	-10	9.35	262	12.8	95.6	
12:52 pm	0	9.40	263	12.0	95.0	
1:22 pm	+10	9.40	263	11.7	95.0	
1:52 pm	+20	9.45	264	11.2	94.5	
2:22 pm	+30	9.50	266	18 to 26	94.0	Erratic distortion
3:10 pm	+40	9.45	264	18 to 26	94.5	of waveform traced to
4:12 pm	+30	9.45	264	10.2	94.5	loose connection.
5:00 pm	+40	9.45	264	9.5	94.5	
5:40 pm	+50	9.40	263	8.5	95.0	
6:15 pm	+60	9.45	264	9.0	94.5	
6:45 pm	+65	9.40	263	8.5	95.0	
10:15 pm/3	+65	9.40	263	8.5	95.0	
10:45 pm	+55	9.60	269	10.0	93.0	
11:15 pm	+45	9.60	269	10.5	93.0	
11:45 pm	+35	9.70	271	12.0	92.2	
12:05 am/4	+25	9.90	277	14.0	90.3	
12:15 am	+25	9.90	277	14.0	90.3	
7:30 am	+25	10.00	280	14.0	89.3	
						End of temperature testing

VIBRATION TEST DATA

(Mechanical Results)

Item under test: Amplifier, AM-6482 (XLW-1)/UIQ-10 S/N P1 (unmodified)

RESONANCE SURVEY

Axis of Vibration	Resonances found (Hz), Mechanical Results	
Minor Horizontal	63.5, 127, 254,	Serious "oil-canning" of case over relay bracket, especially at 127 Hz.
Vertical	125, 250,	Again serious "oil-canning" of case over relay bracket at 125 Hz. Circular crack forming around rosette weld. Test halted at this point.
Major Horizontal	Not performed	

Item under test: Amplified, AM-6482 (XLW-1)/UIQ-10 S/N P1 with stiffener plate and larger relay mounting bracket

RESONANCE SURVEY

Axis of Vibration	Resonances found (Hz), Mechanical Results	
Vertical	Broadband Resonance 130 to 350 peak at ∿ 320 Hz	Resonance center located on center of base of case. No visible indication.
Major Horizontal	Broadband Resonance 300 to 500 peak at ∿ 375 Hz	Resonance center located on case over relay bracket No visible indication.
Minor Horizontal	Broadband Resonance 150 to 190 peak at ∿ 163 Hz	Resonance center located case over relay bracket. Slight "oil-canning" detected.

273, 327, 365, 405, 457 and 495, largest resonances at 273, 365 and 405	Resonance center located on center of base of case. No visible indication.

RESONANCE DWELL (1/2 hour at each Resonance)

Axis of Vibration	Resonance Frequency (Hz)	Visual Examination Results
Vertical	320	No visible degradation
Major Horizontal	375	No visible degradation
Minor Horizontal	163	No visible degradation
	273	" " "
	365	" " "
	405	" " "

Item under test: Control, Amplifier C-8967(XLW-1)/UIQ-10 S/N P1

RESONANCE SURVEY

Axis of Vibration	Resonances found (Hz)	Mechanical Result
Vertical	420	Resonance centered on belt clip
Major Horizontal	390, 475	Resonance centered on belt clip
Minor Horizontal	None	

RESONANCE DWELL (1/2 hour at each resonance)

Axis of Vibration	Resonance Frequency (Hz)	Visual Examination Results
Vertical	420	No visible degradation
Major Horizontal	390	No visible degradation
	475	" " "
Minor Horizontal	None	

Items under test: C-8967(XLW-1)/UIQ-10 and AM-6482(XLW-1)/UIQ-10, amplifier modified with stiffener plate and larger relay mounting bracket.

CYCLING VIBRATION (15 minutes total in each frequency range)

Axis of Vibration	Frequency Ranges (Hz)	Mechanical Results
Vertical	5 - 26 - 5	No visible degradation
	26 - 52 - 26	" " "
	52 - 500 - 52	" " "
Major Horizontal	5 - 26 - 5	" " "
	26 - 52 - 26	" " "
	52 - 500 - 52	" " "
Minor Horizontal	5 - 26 - 5	" " "
	26 - 52 - 26	" " "
	52 - 500 - 52	" " "

Relation to Vibration Tests	Date	Current In A	Power In W	Distortion %	Efficiency %	Comments Comments
Before	4 Aug.	10.0	280	14.0	89.3	
After	13 Aug.	9.55	268	15.0	93.5	This test took place after Q7 (2N3253) was replaced to correct an intermittent operating condition

TEST EQUIPMENT

1. Temperature Tests. All temperature tests were performed in a Tenny Temperature Chamber, Model T64UF-100-240.

2. Vibration Tests. The vibration tests were performed using the following test equipment:

Description	Manufacturer	Model/Type Number
Shaker	Calidyne	177A
Audio Amplifier	Westinghouse	GF
Servo Cycling Oscillator	Line	SCO-100
Control Console	Calidyne	94
Vibra-plane	Allied Research Assoc.	407-C1

3. Distortion and Efficiency Tests. The electrical tests were performed using the following test equipment:

Description	Manufacturer	Model/Type Number
Power Supply	Hyperion	HY-SS-26-20
Test Oscillator	Hewlett-Packard	651B
Vacuum Tube Voltmeter	Hewlett-Packard	410B
RMS Voltmeter	Hewlett-Packard	3400A
Distortion Analyzer	Hewlett-Packard	330B
Attenuator	Hewlett-Packard	355D
Load	Ohmite	270-175P-46
Variable Electronic Filter	Spencer-Kennedy Labs	302
Oscilloscope	Tektronix	535A
Oscilloscope Preamplifier	Tektronix	1A2
Volt-ohm-Ammeter	Triplett	630

APPENDIX C

RFI/EMC INVESTIGATION ON

PUBLIC ADDRESS SET AN/UIQ-10

Appendix C

TECHNICAL REPORT

RFI/EMC INVESTIGATION

on

Public Address Set
AN/UIQ-10(XLW-1)

Contract DAAD05-71-C-0371

Prepared by:

Bendix Field Engineering Corporation
9250 Route 108
Columbia, Maryland 21043

Dated: 22 October 1971

ABSTRACT

This investigation determined the degree of interference and explored two methods of suppression. The filter method of suppression was found to be unacceptable. The shielding method met with limited success with certain qualifications.

Shielding and the use of a powerline filter is the recommended approach to achieve a reduction of undesirable emissions.

FOREWORD

This report describes the RFI/EMC investigation performed on the AN/UIQ-10 (XLW-1) Public Address Set. The purpose of this investigation was to identify emissions and sources and evaluate the possible RFI fixes. The conclusions of this investigation are summarized at the end of this report.

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LIST OF ILLUSTRATIONS

1. ORIGIN AND CHARACTERISTICS OF UNDESIRED EMISSIONS

The design concept of the AN/UIQ-10 employs high speed, high current switching circuitry to achieve the optimum operational efficiency factor, and it is this circuitry which radiates the interference signals. Also, it appears that the high frequencies in the transients are ringing parasitic resonant circuits which further add to the undesired emanations.

For the most part, the emanated spectral distribution remains fixed in frequency, but does varies in field strength as a function of the mode of operation and the number of external leads connected to the amplifier. That is; with all speaker leads disconnected, the mass of emanations between 10 and 30 MHz are eliminated, but the spurious or parasitic signals remain unchanged. In addition to the prototype, two other amplifier units were tested and also found to contain the parasitic emanations.

2. TEST CONFIGURATION AND ANALYSIS

A test configuration baseline was established which consisted of the amplifier case being electrically connected to a table ground plane within a RFI shielded room with the power and speaker leads remoted to the outside. This configuration was devised to determine the measurable ability of the case to contain emanations if the shielding integrity is not violated with external leads acting as antennas. Also, this configuration would be representative of the maximum radiation suppression to be expected by filter or shielding modification techniques. The tests were conducted in accordance with MIL-STD-461 and revealed emanations with strength in excess of the radiated emission limits. This indicated that no amount of shielding or filtering of the present AN/UIQ-10 design will be sufficient to meet the radiated emission limits of MIL-STD-461.

3. MIL-STD-461 COMPLIANCE MEASUREMENT RESULTS

Radiated and conducted measurements were performed in accordance with the requirements of MIL-STD-461, and the results are illustrated in figures 1 through 5.

Figure 1 is representative of the emissions to be encountered in a typical field application. While this test was being performed, a comparison of emission amplitudes was made between the conditions of grounding and ungrounding the amplifier with a single contact to a ground rod. The difference in either condition was small or none. Therefore, the data is presented for only the grounded case because it is also representative of the ungrounded emission levels. The purpose of this test was two fold; determine the effect of grounding on the radiated emissions (as mentioned above), and provide baseline data to evaluate the shielding room test environment effect on the radiated measurement accuracy.

Figure 2 shows the measurement results of a set-up similar to that used for figure 1 except for being located in a shielding room. Comparison of the

same frequency regions as illustrated in figures 1 and 2 reveal approximately equivalent results indicating the shielded room effect is noticeable, but not excessive.

Figure 3 indicates the measured levels of emissions after completion of all the shielding applications that could logically be used with the existing amplifier housing design. This data is the proof that no fix to the existing housing will reduce the emissions to a level which would be compliant with MIL-STD-461.

Figures 4 and 5 are results of the powerline conducted interference measurements. In comparison with the previous measurements, these results, which are in excess of MIL-STD-461 limits, were expected. Levels of these magnitudes will require considerable suppression before this system can share a power source with any other electronic equipment.

Other radiated measurements using probes and antennas were made with various modifications of the test set-up. These measurements indicated:

a. Each line (control cable, power cable, and speaker lines) contributes to the radiated interference problem.

b. With all lines shielded, the radiation is still present and is emanating from the amplifier box ends containing the cable connectors.

c. The exposed collectors of the four power transistors are not a source of radiated leakage.

d. Shields for the cables would also radiate unless they are continuously connected to the ground plane.

4. RADIATED EMISSION ANALYSIS

Figure 6 through 13 are spectrum analyzer photographs displaying radiated emissions. While the spectrum presented consists of 15 to 385 MHz, the test antenna used with the analyzer for these measurements has a calibrated response for only the 20 to 200 MHz range. However; this fact does not significantly affect the intent of these measurements which is to graphically illustrate, for purposes of comparison, each cables contribution to the total radiated interference.

5. SUPPRESSION METHODS AND ANALYSIS

Test results to this point suggest two possible RFI fix methods; i.e., filter or shielding suppression. The following describes the results of an application of both methods.

a. Filter Suppression Investigation:

Current probe tests indicated that the maximum emissions were from the cable between the amplifier and the control box. Emissions were also measured

directly from the amplifier and from the speaker leads; but the relative levels were 20 to 30 dB greater from the control box cable when being measured with a loop probe. This condition was later established as the baseline and used to justify current probe measurements on this cable as being representative of any RFI fixes.

The initial attempt to control the emissions was based on an approach of completely isolating the switching circuits. Filters were placed in the B+ and B- leads, output speaker leads, and driver input (audio into the switch circuity) leads; in addition, the B- lead was separated from chassis ground. The filters in the output speaker leads caused a mismatch in the switch timing and resulted in generating stronger emissions. The filters in the audio input leads caused an unbalance in the switch circuit and resulted in a quiescent current in excess of four amperes. There were no changes in the emission level, either conducted or radiated, with or without the filters in the B+ and B- leads. Similarly, isolation of the B- leads from chassis ground resulted in no difference as compared to grounding the B leads.

Since attempts to isolate the switching circuits failed, an attempt was made to decrease the radiation from one of the prime sources, the control cable between the amplifier and control box. It should be noted that all testing had been performed with the entire AN/UIQ-10 isolated from ground. To decrease the emissions from the cable, an attempt was made to create a pseudo ground at the input to the amplifier; that is, referencing the RFI to this point and isolating the cable from RFI currents. This attempt failed because the reference was necessarily the amplifier chassis, and the chassis was an emitter in itself. It was noted that when the chassis was connected to the test groundplane, the control cable ceased to be an emitter. However, it was also noted, that as long as the chassis was grounded, there was no difference with or without the filters in the control cable leads.

b. Shield Suppression Investigation:

Figure 6 depicts the best emission suppression results which can be expected with the existing design using shielding techniques. Note the 165 MHz parasitic; this emission, together with a 330 MHz parasitic, can be seen in most of the other photographs.

Figure 7 is an indication of the system emissions in a configuration that would normally be used in field applications and in general, illustrates a typical worse-case condition.

Figures 8, 9, 10, and 11 are all variations of the completely shielded test configuration used in figure 6. These modified set-ups prove that each external lead does contribute to the total radiated interference.

Figure 12 provides a more detailed amplitude versus frequency analysis of the parasitic at 165 MHz. The parasitic at 330 MHz is also distributed across several MHz and is almost identical to the 165 MHz emission.

In order to approach meeting MIL-STD 461 requirements, the amplifier, control box, and speaker drivers would require significant changes in housing and connector hardware. These changes should be directed toward attaining an unbroken continuous shield to and between these components. This would involve r-f gasketing all access plates, removal of speaker binding posts, shielded connectors and cables for all interconnecting leads, r-f tight connector caps for connectors not used, a powerline filter box to permit operation from a battery supplying other electronic equipment, and special housing on the speaker drivers to assure shielding continuity.

6. CONCLUSIONS

Filtering as a practical fix is ruled out. The results of the completely shielded test set-up, while not meeting MIL-STD-461 requirements, did provide significant reductions in the radiated emanations. These reductions, are approximately 40 dB in the 0.1 to 1 MHz region and 10 to 30 dB in the 10 to 100 MHz region. These levels of reduction are the best that could be expected if a thorough shielding of all interconnecting cables were the only fix applied to the existing design.

In order to achieve these idealized results, the following must be considered:

a. Some degradation in shielding efficiency will occur at the connections to the speaker drivers.

b. The efficiency of any fix will be destroyed if wires are connected to the amplifier binding posts.

c. The shielding fix will not prohibit the conducted interference that will occur if the amplifier shares a battery that is supplying other electronic equipment - a powerline filter box must be used.

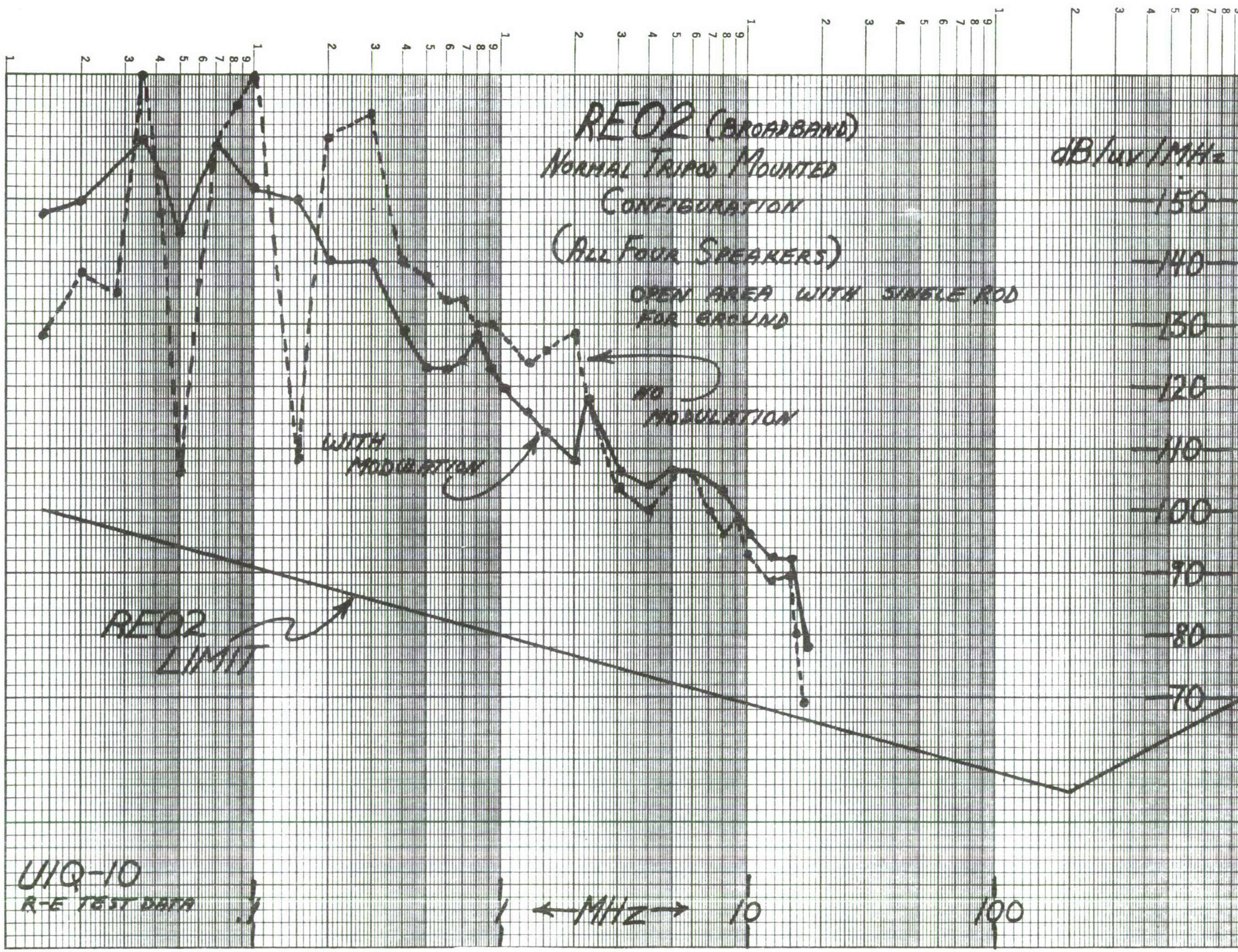

Figure 1. RE02 Test Data - Open Area Environment, Single Ground Rod

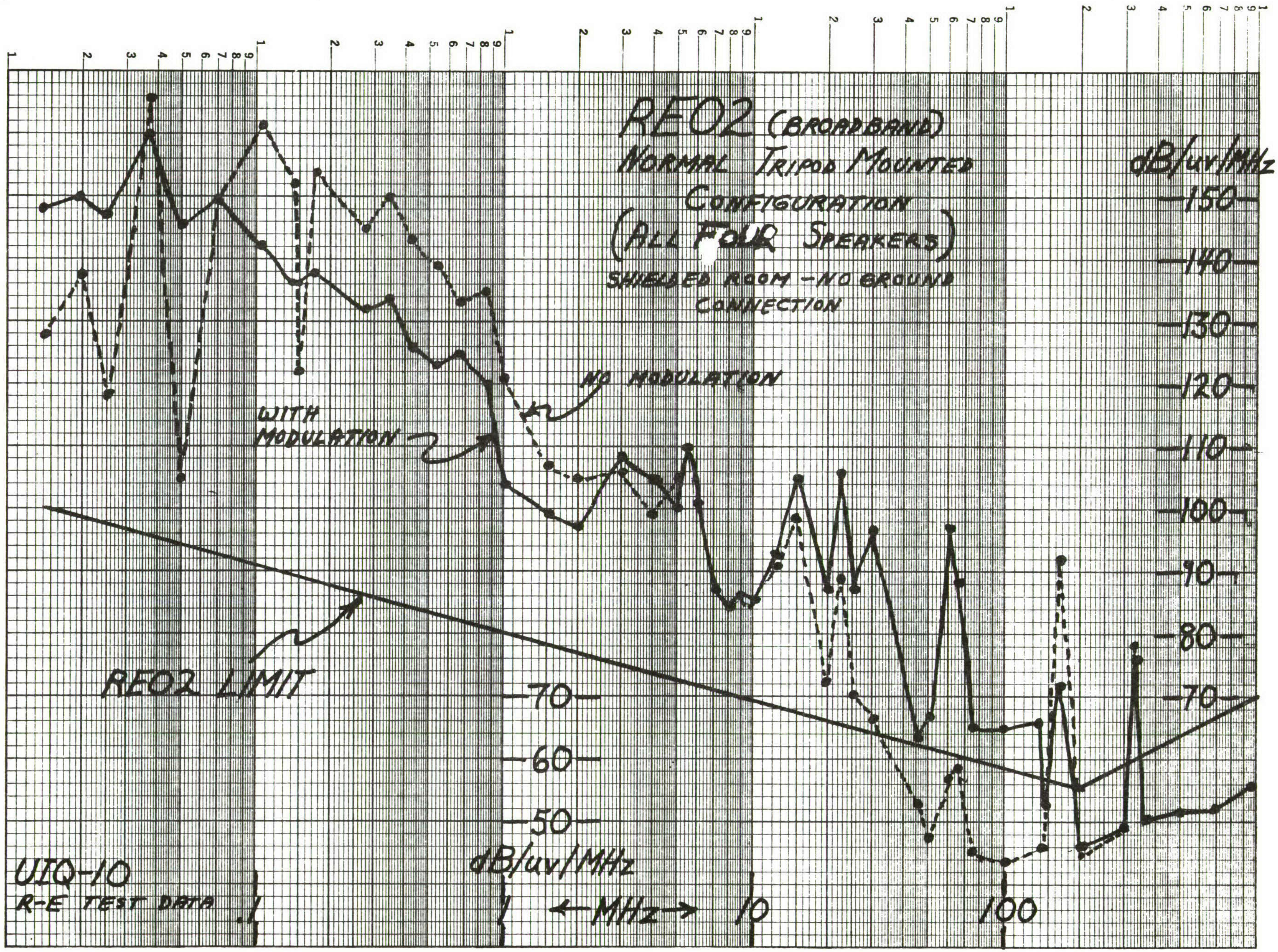

Figure 2. RE02 Test Data - Shielded Room Environment, No Ground Connection

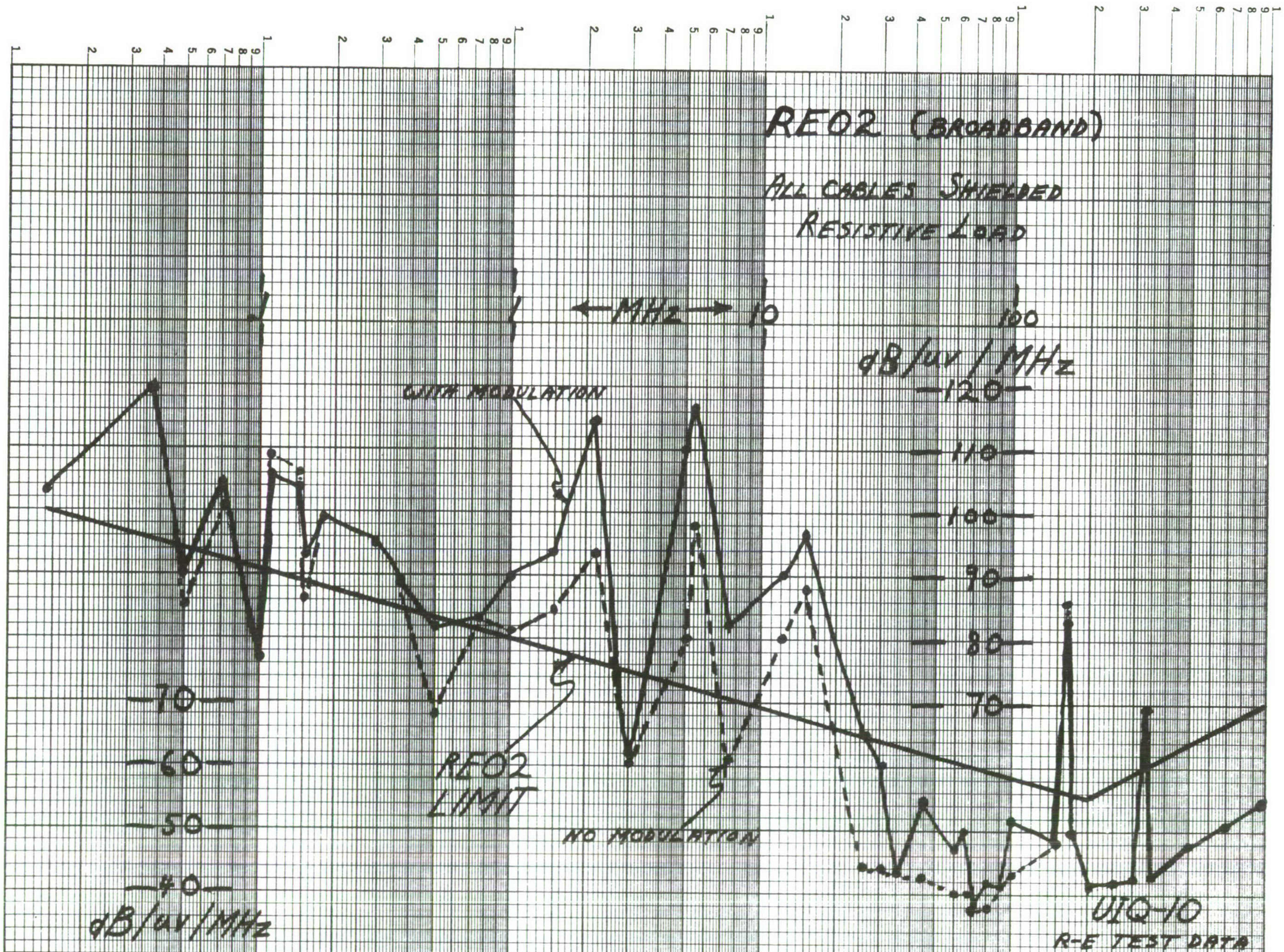

Figure 3. RE02 Test Data - All Cables Shielded

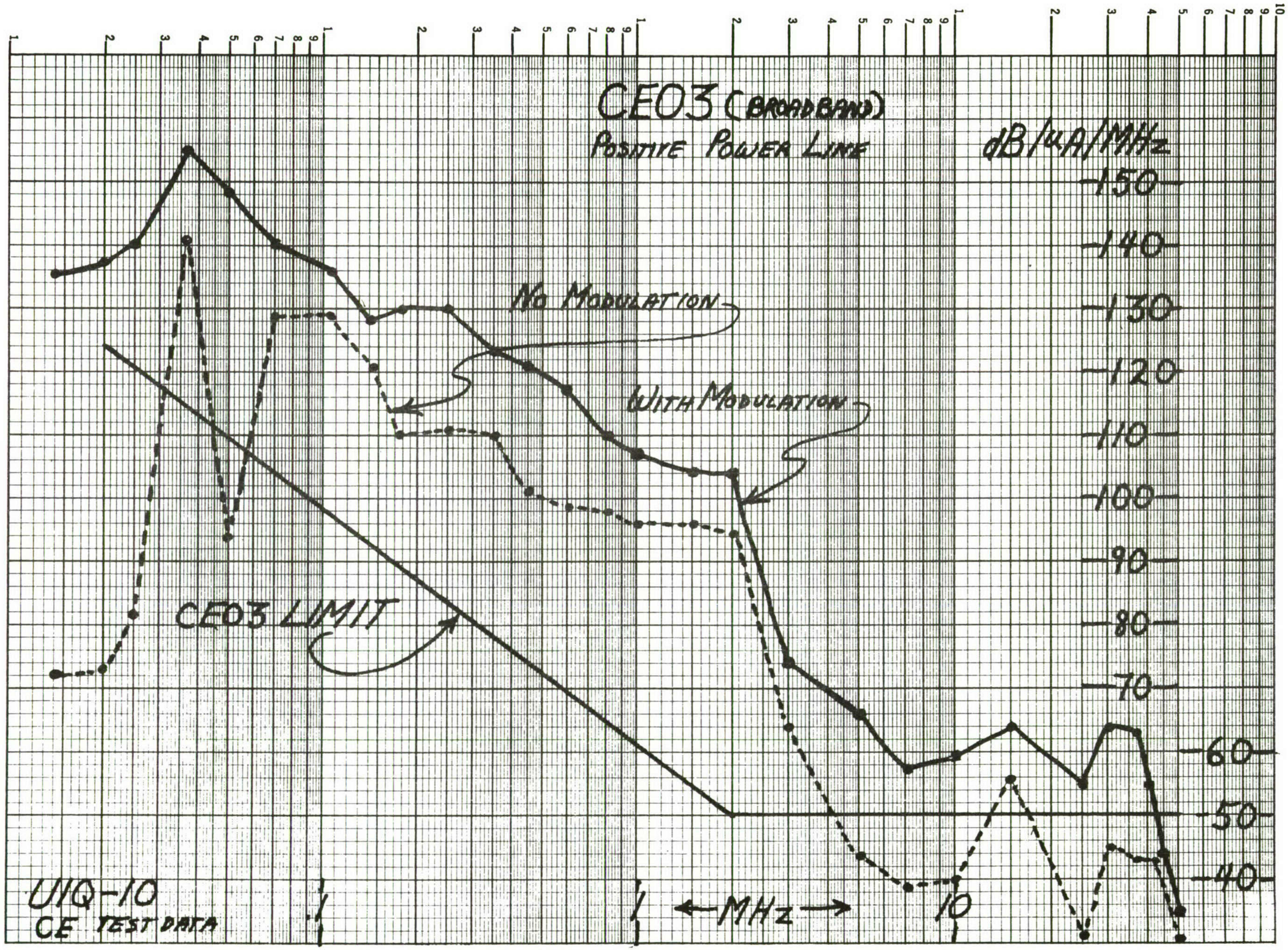

Figure 4. CE03 Test Data - Positive Power Line

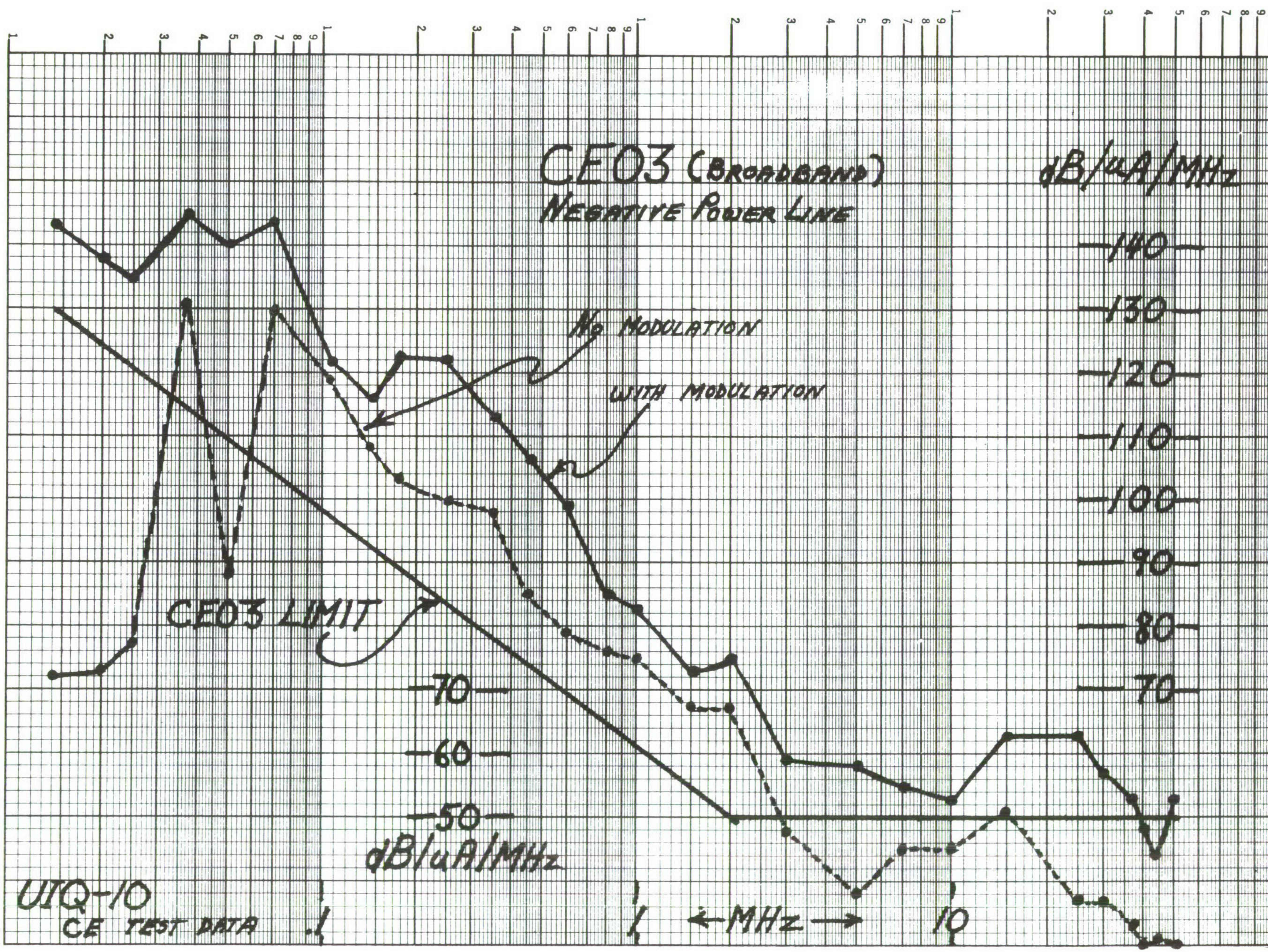

Figure 5. CE03 Test Data - Negative Power Line

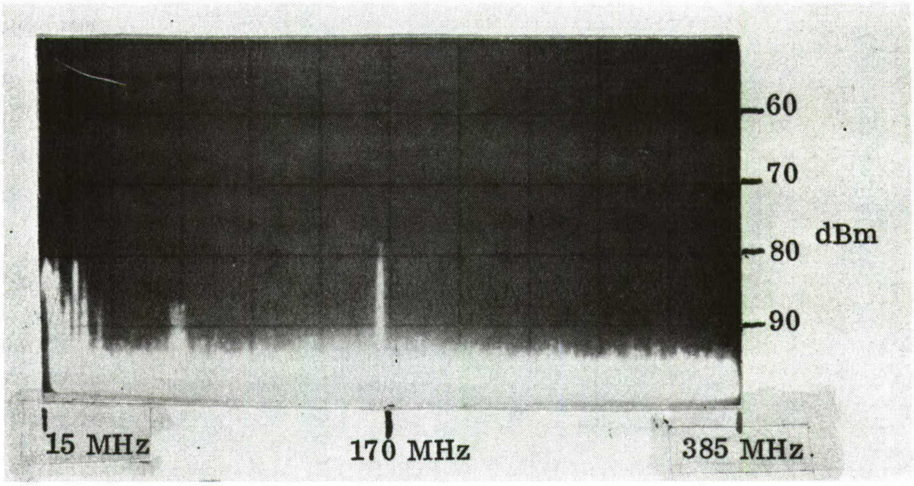

Figure 6 - All Cables and Load Shielded

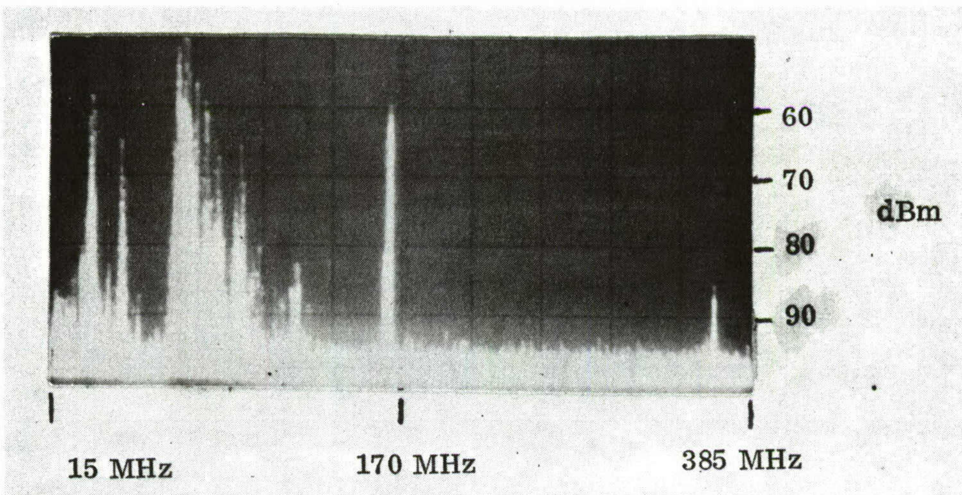

Figure 7 - Normal Tripod 4-Speaker Configuration

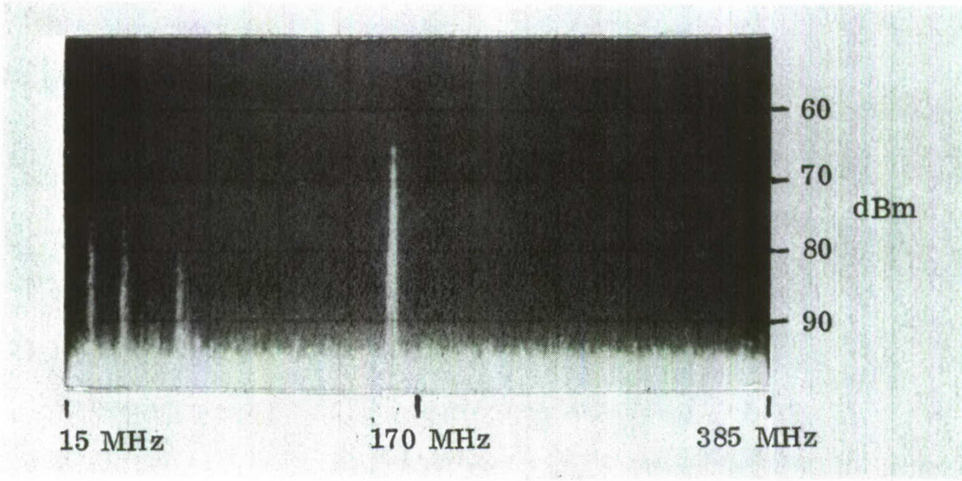

Figure 8 - One speaker connected with
9-inch lead. All other lines & load shielded.

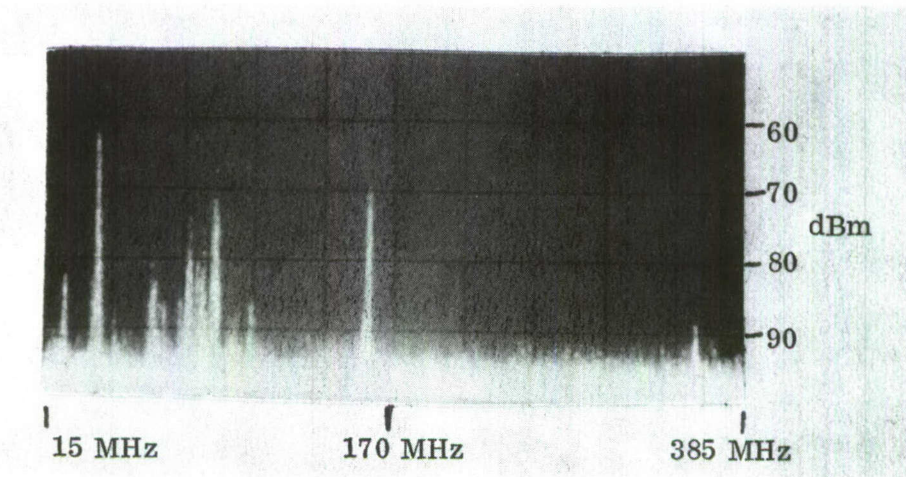

Figure 9 - Five feet of control cable exposed.
All other lines and load shielded.

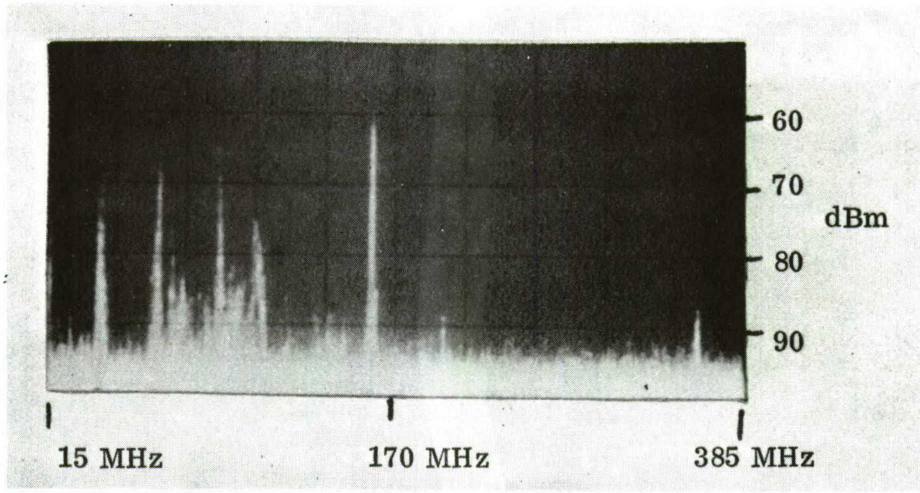

Figure 10 - Five feet of power cable exposed.
All other lines and load shielded.

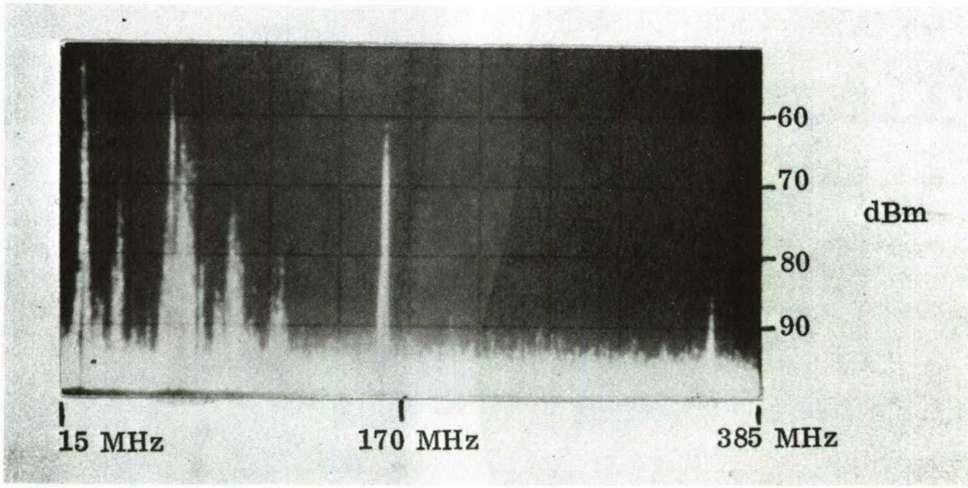

Figure 11- All speakers connected and lines
exposed. All other lines shielded.

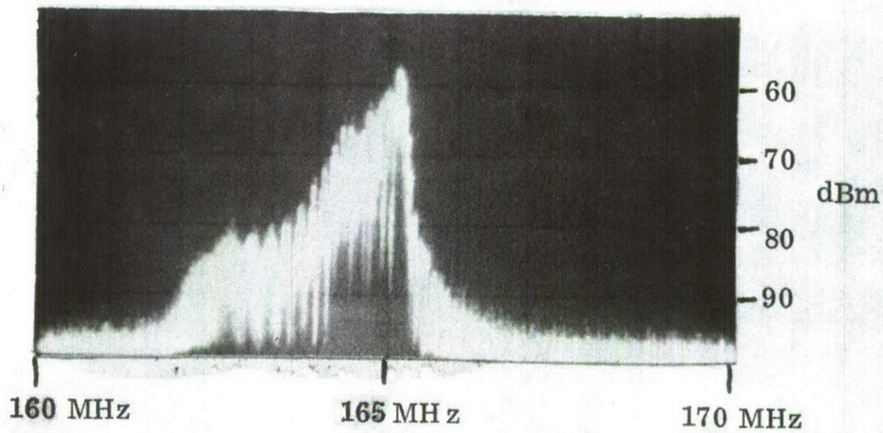

Figure 12- Parasitic Emission detail

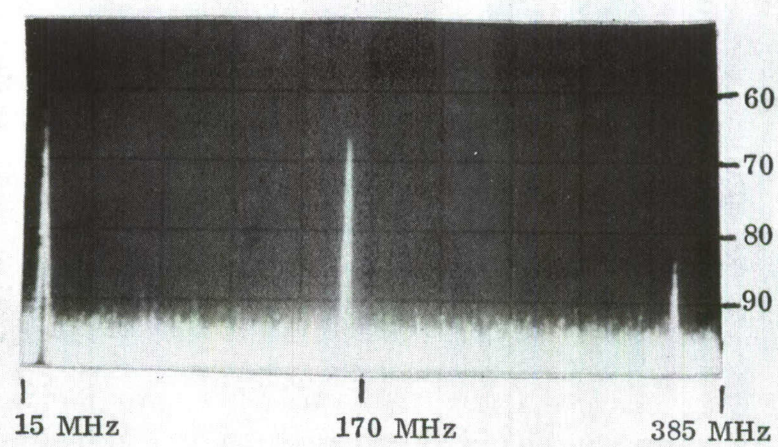

Figure 13- Speaker leads only exposed.
All other lines shielded.
No modulation.

APPENDIX D

US ARMY TESTS OF PUBLIC ADDRESS SET

AN/UIQ-10

APPENDIX D

DEPARTMENT OF THE ARMY
92D PSYCHOLOGICAL OPERATIONS COMPANY (TACTICAL)
FORT BRAGG, NORTH CAROLINA 28307

ATCMA-PO92(TAC) 13 March 1973

SUBJECT: Public Address Set, AN/UIQ-10 Evaluation

THRU: Commander
8th Psychological Operations Battalion
ATTN: ATCMA-PO8-SC
Fort Bragg, North Carolina 28307

TO: Commander
U.S. Army Land Warfare Laboratory
ATTN: MAJ Alex Johnston
Aberdeen Proving Ground, Maryland 21005

1. Per your request the evaluation of the Public Address Set, AN/UIQ-10 conducted by this unit is attached.

2. I trust this evaluation will be of some value to you and satisfactorly meets your requirement.

3. It was a pleasure for us to participate in your program and the Public Address Set, UIQ-10 was well received by this units personnel, in fact when given the latitude it is used exclusively by them in preference to the UIH-6.

C Kent Jackson
CLAUDE K JACKSON
MAJ, IN
Commanding

1 Incl
as

EVALUATION OF UIQ-10 AND UIH-6

The public address systems UIH-6 and UIQ-10 are both portable and have been used extensively by this unit under varied environmental and meterological conditions while in support of US Army units in field training exercises, as well as garrison employment in support of training and maintenance programs.

Although the sets UIH-6 and UIQ-10 have similar nomenclature and characteristics it was found that there were several notable differences in the performance, transportability, quality of sound, and ease of employment.

Both sets are powered by 24 volt DC rechargeable batteries, however, the nickel battery of the UIQ-10 was found to be superior over the nickel cadmium battery associated with the UIH-6 system.

The power rating for both units is 250 watts with the frequency response ranging from 500 HZ - 5000 HZ for the UIH-6 to 450 HZ - 3000 HZ for the UIQ-10. The frequency difference should have allowed the UIH-6 to provide better reproduction for various inputs, however, under actual field use and testing the reverse was found to be true. This area of sound quality was of concern. It was found that the quality of sound produced by the UIQ-10 greatly surpassed that of the UIH-6. Both sets have comparatively good quality for voice broadcast, however, when music was used as an input to the sets, it was found that the UIQ-10 yielded much better sound quality. These data are based on test conducted using the same tape source under identical conditions and time. For the next series

of test numerous tapes were employed with various type musical recordings to compare performance and again the UIQ-10 surpassed the UIH-6 in sound quality.

At this echelon we were not able to conduct a satisfactory scientific investigation into the cause of the obvious difference in sound quality reproduction between the two sets, however, it is suspected that a probable cause could be that the speaker on the UIH-6 is inferior to the UIQ-10 and this results in the producing of the "tinny" sound. The overall quality of sounds was less acceptable for the UIH-6 than the superior sound obtained from the UIQ-10.

A notable and significant difference between the two sets is that of weight. Although the UIQ-10 outweighs the UIH-6 by some 13 pounds the advantages found with the former more than compensates for this slight advantage to the latter.

Both sets require two men to properly transport, however, it was found that the UIQ-10 can be made operational with one man transporting and operating the amplifier control unit with loudspeaker (loudspeaker assembly transported by the second individual of the team could be left behind without completely negating the effectiveness of the system) and this is not true for the UIH-6.

Another area of interest was the length of time each set could effectively operate prior to a battery recharge. Our field test revealed that the UIQ-10 system using the nickel type battery outlasted the UIH-6 system consistently by 3 to 4 hours while in continuous operation. It should be noted that during these tests, although under identical conditions and pro-

grams, neither set was operated at maximum rated power output for extended periods of time. The length of operating time on the UIH-6 was determined to be a shortcoming as a result of the excessive downtime for recharging. This is most vividly demonstrated by the fact that during the period 4 July - 24 Aug 1972 this unit while in support of reserve components, at Fort Stewart Georgia, broadcast an average of 8 hrs out of each 24 hour period and the UIH-6 required recharging during the day while the UIQ-10 performed without interruption the entire day. Without exception the UIH-6 power source is depleted long before that of the UIQ-10 and this necessitated returning from the forward area to a power source and awaiting the recharge of batteries.

It is recognized thatthis shortcoming could be overcome by supplying a second set (float) of batteries, however, the extra charged batteries would have to be carried or brought forward at the appropriate time causing extra weight and incovenience.

A very significant factor in comparing the two systems was that although the batteries for the UIH-6 outweighs the UIQ-10 (16.0 lbs vs. 8.0 lbs respectively) there is in fact a decreased time frame for availability of the UIH-6.

Another area of concern when comparing the two systems is the obvious limitation placed on the operation of the UIH-6 at maximum output (volume) on a continuing basis by the warning. Again this was most amply demonstrated in the Fort Stewart Testing.

An area of major concern was the flexibility of employment for the systems. Overall the UIQ-10 was found vastly superior for the following reasons: (1) By virtue of the backpack board and straps the UIQ-10 was more manageable, less fatiguing and could be transported greater distances. The troops employed in testing the UIQ-10 were most impressed as they found it less burdensome to them. (2) By virtue of the additional loudspeaker assembly we were able to gain 360° coverage from the site of employment. This was felt to be a most worthwhile advantage when compared to the limited quadrant coverage of the UIH-6. Although it is realized that the 360° capability will seldom be required or utilized, the very fact that the capability exists allows for any contingency in the employment of the system. This capability has been used in conjunction with the built-in attack alarm and alert alarm systems which will be discussed later in this report. The above capability when comparing the two systems places the UIQ-10 in a class above the UIH-6 with its limited ability to cover more than one quadrant at a time, a definite shortcoming when employed in the PSYOP role by this unit. (3) The range of the UIQ-10 broadcast was found to be less than that of the UIH-6, however this was not determined to be a disadvantage as it has been our experience that the effectiveness of a loudspeaker system in reaching the desired target audience is more dependent upon dispersion or quadrant coverage and quality rather than the sheer range of the system. The normal tactical audience configuration is linear as opposed to depth. (4) The attack alarm and alert alarm, without exception, have received the highest praise from the Commanders of the combat units we have supported and opposed during the testing periods for the UIQ-10.

In the areas of maintenance and dependability the UIQ-10 has proven to be acceptable to the standards required for a TOE Unit. The UIQ-10 failed once during the testing period. The failure was a result of a short within the wiring of the amplifier. There was minimal loss of time and the deficiency was easily rectified. There were no failures for the UIH-6 during this same testing period. (It should be noted that the UIQ-10 tested has been in constant service for a period of one year, while the UIH-6 used for testing has less than nine months of service).

As result of our test, use, and employment of the UIQ-10 several suggestions concerning possible improvements are offered:

(1) Microphone connectors on the control unit be modified to a thread-type connection. — This would facilitate ease of connection for the operator under field conditions and result in a more secure connection.

(2) The above connectors be displaced from their present location (top and under speaker) to a side location. This would eliminate the close proximity of the microphone connection to the broadcast speaker which proved to be awkward for the operator while in the field under simulated combat conditions, especially in cold weather while using gloves or mittens, it was found impossible to make the connection without first removing the protective hand coverings.

The troop acceptance was found to favor the UIQ-10 for the reasons enumerated in the body of this report. The supervisors favored the UIQ-10 for its flexible employment, ease of transportation, longer battery availability. and quality of sound. The commanders displayed enthusiasm for the additional

incorporated features such as the additional loudspeaker assembly, and especially the attack alarm and the alert alarm incorporated into the UIQ-10 loudspeaker system.

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